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AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA PART 5. MONOCOTS EXCEPT GRASSES

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ABSTRACT

A floristic account is provided for the eleven monocot families except the grass family as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in southwestern Arizona: Amaryllidaceae, Asparagaceae, Commelinaceae, Cyperaceae, Hydrocharitaceae, Iridaceae, Juncaceae, Liliaceae, Potamogetonaceae, Ruppiaceae, and Typhaceae. This is the fifth contribution for this flora, published in Phytoneuron and also posted open access on the website of the University of Arizona Herbarium (ARIZ).

KEY WORDS: flora, southwestern Arizona, monocots

Twelve monocot families occur in the flora area of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in southwestern Arizona (Figure 1). This contribution includes all the local monocots except the Poaceae: Amaryllidaceae, Asparagaceae, Commelinaceae, Cyperaceae, Hydrocharitaceae, Iridaceae, Juncaceae, Liliaceae, Potamogetonaceae, Ruppiaceae, and Typhaceae. These eleven families include 35 taxa (34 species and one hybrid) in 22 genera. Six of these species are known from fossils from packrat middens, two of which are no longer present in the flora area: Spanish bayonet (*Hesperoyucca*) and Joshua tree (*Yucca brevifolia* and/or *Y. jaegeriana*). There are no non-natives among the 11 families. In addition, one non-native, a palm (Arecaceae), is no longer present and an arrowhead (Alismataceae) may have once been present.

The 35 taxa include a wide range of growth forms including ephemerals (annuals), delicate submerged aquatics, annual and perennial wetland plants, succulent-leaved rosette plants, shrub- or small-tree-sized rosette plants, and geophytes. There are six bulb-forming geophytes: *Allium*, *Calochortus*, *Dichelostemma*, *Habranthus*, *Hesperocallis*, and *Triteleiopsis*. These geophytes have showy flowers and are prominent during their particular growing and flowering/fruiting season but during dormant times, which are the majority of months of the year, above-ground parts generally will not be seen.

This is the fifth contribution to our flora in southwestern Arizona, following the introduction of the flora (Felger et al. 2013a), a checklist of the modern and fossil flora (Felger et al. 2013b), the fern, lycopods, and gymnosperms (Felger et al. 2013c), and the magnoliids (Felger et al. 2013d). These contributions are also posted open access on the website of the University of Arizona Herbarium (ARIZ). Explanation of the format for the species accounts in this and forthcoming contributions is provided in part 3 (Felger et al. 2013c). Taxa no longer occurring in the flora area are not included in the keys. Fossil specimens are indicated with a dagger symbol (†) and taxa represented by fossils no longer present in the flora are marked with two dagger symbols (††). Descriptions pertain to taxa and populations as they occur in the flora area. All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2013).

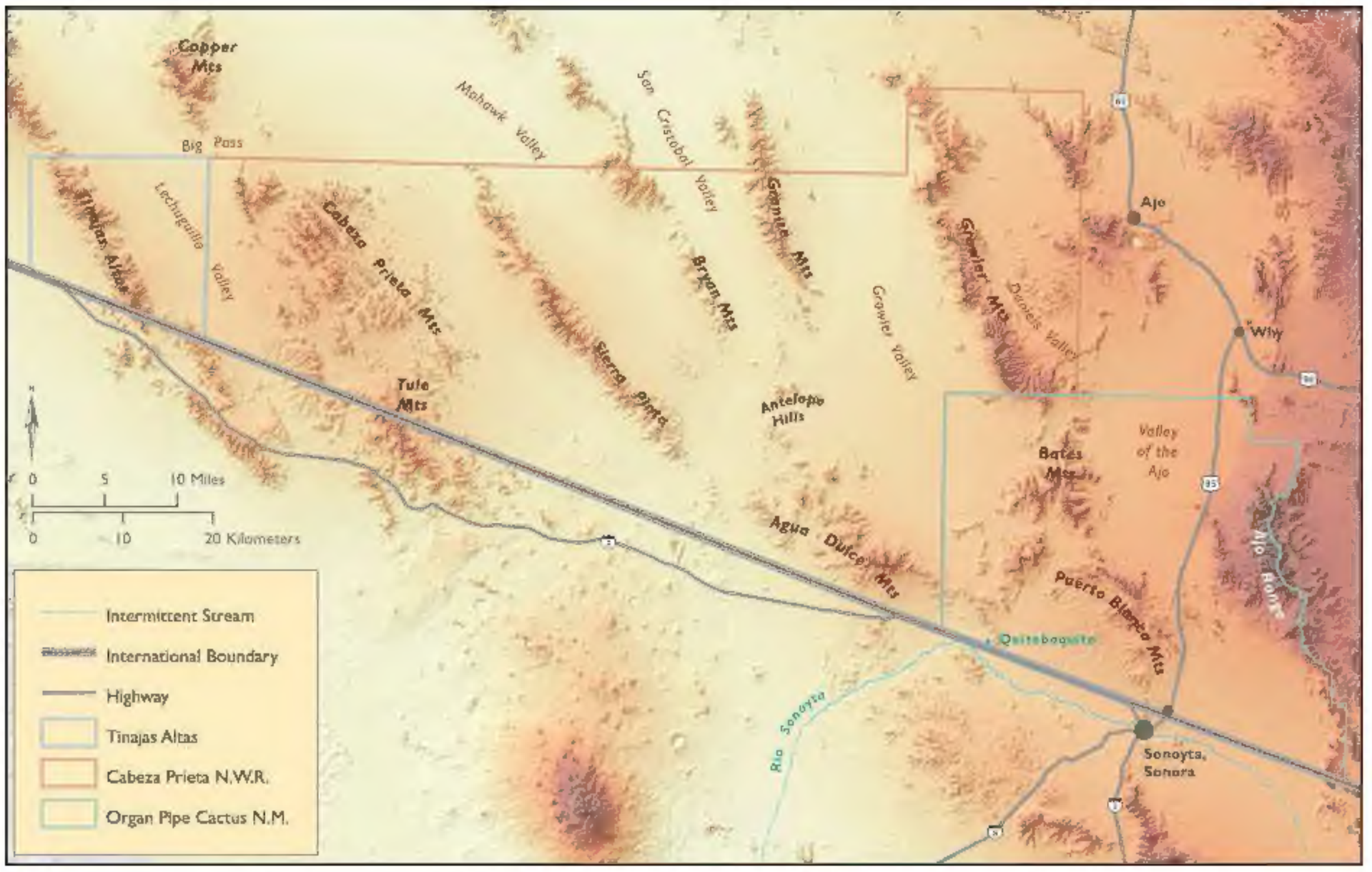

Figure 1. Flora area in southwestern Arizona. Map prepared by Ami Pate of Organ Pipe Cactus National Monument, 2013.

1. Fully submerged aquatic plants; leaves thread-like (filiform) or linear.

    2. Stems and leaves beset with coarse teeth or spines; leaf blades linear but not thread-like ..... **Hydrocharitaceae**
    2. Stems and leaves unarmed; leaf blades thread-like.

        3. Leaves at least mostly opposite; fruits asymmetric, laterally compressed (flattened), oblong (longer than wide), with small teeth on a crest ..... **Potamogetonaceae** (*Zannichellia*)
        3. Leaves at least mostly alternate (sometimes appearing opposite at stem tips); fruits asymmetric or not, nearly round to ovoid (about as wide as long), not toothed.

4. Leaf tips entire (without submicroscopic teeth); fruits asymmetric, sessile, one to several unevenly along a slender spike, the fruiting peduncles not elongating ..... **Potamogetonaceae** (*Potamogeton, Stuckenia*)
4. Leaf tips usually with submicroscopic teeth; fruits symmetric, 4 in a cluster and stalked, the peduncles greatly elongating in loose coils as the fruits develop .....**Ruppiaceae**

1. Plants terrestrial or emergent from shallow water; leaves variable.

5. Agaves, yuccas, and beargrasses; leaves firm, succulent, and armed at least with a stout terminal spine, or leaves flat or semi-succulent and the plants with a woody caudex or trunk .... **Asparagaceae** (*Agave, Nolina, Yucca*)
5. Plants not woody and leaves not spinescent (*Juncus cooperi* has spine-tipped leaves and inflorescence bracts but it is not woody).

6. Perennials from underground bulbs, corms, or thick roots or rhizomes; flowers colorful and showy, whitish, pinkish, bluish, yellow, or orange.

7. Stems conspicuously leafy; flowers bilaterally symmetrical, blue, and liquefying with mid-morning heat .....**Commelinaceae**
7. Stems (flowering stalks) leafless or with reduced leaves; flowers radially symmetrical, various colors, and not liquefying.

8. Plants without bulbs; leaves numerous and perennial, 2-ranked (in a single plane) and folded so that only the "lower" (abaxial) side is visible; perianth blue with a yellow center, the tepals tipped with a small point; rare, Quitobaquito in wet or damp soil …… **Iridaceae**
8. Plants with underground bulbs (corms); leaves few, seasonal, not 2-ranked and not folded as above; perianth of various colors and if blue then the center not yellow; various localities, not in wet soil, localized but not rare.

9. Inflorescences umbellate and multiple-flowered (rarely with only 1 flower); flowers white and pinkish, or bluish purple to lavender-pink, less than 2 cm long or wide.

10. Flowers white and pink, on stalks mostly 8–21 cm tall..... **Amaryllidaceae** (*Allium*)
10. Flowers blue to lavender-pink, on stalks usually more than 20 cm tall .....**Asparagaceae** (*Dichelostemma, Triteleiopsis*)

9. Inflorescence racemose or flowers solitary; flowers white, yellow, or orange, more than 2 cm long or wide.

11. Leaves more than 8 mm wide at mid-length; the margins wavy (crisped); flowers white or nearly so .... **Asparagaceae** (*Hesperocallis*)
11. Leaves 1–5 mm wide, the margins entire; flowers yellow or orange.

12. Leaves 2–5 mm wide at mid-length; inflorescences usually 2–4-flowered in racemes; flowers bright orange, in spring..... **Liliaceae**
12. Leaves 1–1.5 mm wide; flowers solitary and yellow, in summer ..... **Amaryllidaceae** (*Habranthus*)

6. Annuals or perennials but not from underground bulbs or corms; flowers not colorful, the perianth scale-like, or reduced to bristles, or minute or absent.

13. Cattails; leaves linear, often more than 1 m tall, erect, strap-shaped, thickened and pithy, the stems not triangular in cross section; wetland habitats ..... **Typhaceae**
13. Grasses, sedges, and rushes; leaves less than 1 m long, or if 1 m or more then not thickened and pithy (*Schoenoplectus* stems are leaf-like but triangular in cross section); wetland or dryland habitats.

14. Rushes; perianth segments 6 and clearly visible as 3 outer and 3 inner segments, brownish, membranous, sometimes with a green mid-stripe; fruits many-seeded ..... **Juncaceae**
14. Grasses and sedges; perianth often not evident, reduced to bristles, microscopic scales, or absent; fruits 1-seeded.

15. Sedges and bulrushes; wetland habitats or at least temporarily wet soils; stems triangular or terete, solid (pithy); leaf sheaths usually closed; each flower subtended by a single bract ..... **Cyperaceae**
15. Grasses; wetland to desert habitats; stems terete, hollow or solid; leaf sheaths usually open; each flower usually subtended by two bracts (the lemma and palea) .....**Poaceae** (not included in Part 5 in this flora series)

AGAVACEAE, see ASPARAGACEAE

ALISMATACEAE – Water-plantain Family

SAGITTARIA sp.?
Arrowhead

Perennial aquatic herbs with emergent arrow-shaped leaf blades. An early photo shows an emergent plant in shallow water at Quitobaquito that seems to be an arrowhead (Felger et al. 1992). The nearest known record is *S. longiloba* Engelmann ex J.G. Smith, which was once present at the delta of the Río Colorado (Felger 2000).

ALLIACEAE, see AMARYLLIDACEAE

AMARYLLIDACEAE – Amaryllis Family

Herbaceous perennials from bulbs. Leaves slender, thread-like or narrowly strap-like. Flowers solitary or umbellate on leafless stalks (scapes). Perianth with 6 tepals, 6 stamens, and a 3-lobed and 3-chambered ovary. Fruits of thin-walled capsules.

1. Plants appearing in cool seasons (usually February to April); inflorescences of multi-flowered umbels (rarely with 1 flower); the flowers white and pink, ovary superior .....**Allium**
1. Plants appearing in warm or hot seasons; flowers solitary, bright yellow, ovary inferior .....**Habranthus**

Allium macropetalum Rydberg
Desert onion; *cebollín*. Figure 2.

Perennials from one or few bulbs, each with a fibrous outer coat. Growing and flowering in spring; dormant during the rest of the year. Leaves often 8–20 cm long, 1–3 mm wide, rounded (terete) to awl-shaped in cross section but not grooved. Flower stalks (scapes) 1–several, often 8–21 cm tall, with (1) several–18 flowers in an umbel subtended by 2 papery spathes (bracts); bracts broadly ovate, translucent white with reddish purple veins. Flowers 8–12 mm long and about 15–18 mm wide when fully open. Tepals lanceolate to ovate, moderately recurved, whitish to pale pink with

a darker pink to red-purple mid-stripe. Filaments white tinged with rose, the anthers reddish purple before dehiscence, the pollen yellow. Ovary superior, the top ornamented with 6 pinkish crests; styles and stigma white. Flowering recorded in February and March; seeds ripening in same season.

Hills, mountains, and rocky upper bajadas; widely scattered, often in locally extensive populations; widely scattered in Organ Pipe and east side of Cabeza Prieta. Generous rainfall results in larger leaves, taller and more robust inflorescences, and more flowers per umbel, while dryer conditions result in overall smaller plants and fewer flowers per umbel.

Southern Utah and southwestern Colorado to Arizona, New Mexico, west Texas, northern Sonora, and northwestern Chihuahua.

Figure 2A. *Allium macropetalum*. Near Chico Shunie, Cabeza Prieta NWR, 26 February 2005; photo by Sue Rutman.

The small bulbs, leaves, and flowers are edible with a strong onion flavor. The Seris used the bulbs to flavor meat (Felger & Moser 1985). Reference to wild onions harvested in Organ Pipe (Bell et al. 1980) and on Table Top Mountain in the Sonoran Desert National Monument (Rea 1997) would be *Allium macropetalum*.

Figure 2B. *Allium macropetalum*. Engineer Canyon, Burro Mountains, Grant Co., New Mexico, 2 Apr 2009; photo by Russ Kleinman (gilaflora.com).

In discussion of the town of Ajo, Zepeda (1985: 23–24) related that, "*Ajo* (a:sos) 'garlic' was of course named by the Spanish people. Mr. [Miguel] Velasco spoke of a mountain that was very steep and rocky. On this mountain many wild garlic plants grew, and so they called the place Ajo, 'garlic.' He says that this mountain is no longer there; it is now a hole in the ground." This *ajo* is probably *A. macropetalum*. However, the site of the Ajo copper mine pit was a source of red pigment (in the form of reduced copper) called something like au:auho, corrupted into 'Ajo.' This O'odham name is believed to be the origin of the town name, rather than the plant.

OP: 3 mi W of Dripping Springs, *Steenbergh 15 Mar 1962* (ORPI). N boundary of Monument, ½ mi W of Bates Well Rd, 12 Mar 1983, *Phillips 83-87* (MNA, ORPI). Puerto Blanco Mts, WNW of Dripping Springs, 1800 ft, edge of small mesic flat in canyon bottom, 7 Mar 1988, *Baker 7585* (ASU).

CP: 7 mi E of Papago Wells, *Harbison* [*17060*] *14 Mar 1937*. Agua Dulce Mts, N of Bassarisc Tank, 26 Feb 1993, *Felger 93-117*. Childs Mt: 2240 ft, 25 Feb 1993, *Felger 93-31*; 9 Apr 1993, *Felger 93-268*. S of Charlie Bell Pass, 9 Apr 1993, *Felger 93-338*. E side of Charlie Bell Pass, Growler Mts, along ancient footpath, N-facing slope with deep rock, sandy soil and cryptogamic cover, white tepals with red midrib, some pink tepals, associated species *Brodiaea*, palo verde-bursage-ocotillo, 1995, *Harlan 449*.

Habranthus longifolius (Hemsley) Flagg, G. Lom. Smith & Meerow
[*Zephyranthes longifolia* Hemsley; *Z. arenicola* Brandegee; *Z. aurea* S. Watson]
Plains rain-lily. Figure 3.

Perennials from one or a few, deeply buried ovoid bulbs 3–4 cm long below a neck 3.5–5+ cm long extending to the soil surface. Leaves several, grass-like, linear-filiform, 12–25 cm × 1–1.5 mm, dark green, semi-succulent, nearly terete with a shallow groove above, the leaf tips become dry, dead, persistent, and usually curled. Flower stalks 1–several per season, 8–20 cm tall, 2–3 mm in diameter, shorter than the leaves, and 1-flowered. Flowers subtended by a membranous spathe-like bract, this quickly drying and splitting as the ovary develops. Flowers held erect, showy; apparently open fully at night and with cooler temperatures, and partially to fully closed with hot daytime temperatures. Tepals, stigma, and style bright lemon-yellow. Tepals 6, petal-like, each 2–3.2 × 1 cm. Stamens 6, unequal in length, the anthers yellow-orange. Ovary inferior, 5–6 mm long at flowering time (anthesis). Capsules 3-lobed, often 10 × 13 mm, and papery at maturity. Seeds black, flat, and D-shaped. Leaves produced in spring and summer; flowers with summer rains in July and August, and perhaps sometimes also in late spring. In cultivated plants in Tucson the fruits matured 10–12 days after anthesis, and C.L. Fouts recorded flowers 8 August 1949 and seeds on the 20th.

Figure 3. *Habranthus longifolius.* ESE of Agua Prieta, Sonora, 2 May 2007 (*Reina G. 2007-524*); photo by Tom Van Devender (MABA/SEINet).

Seasonally and locally common on rocky slopes and flats at higher elevations in the Ajo Mountains. There is also an extensive population at higher elevations in the Sierra Pinacate in nearby northwestern Sonora (Felger 2000).

Southern Arizona generally near and above the upper limits of the desert, eastward to western Texas and northern and central Mexico including both Baja California states.

OP: Ridge between Alamo and Arch Canyons, 3600 ft, N slope, rare, *Fouts 8 Aug 1949* (ORPI). Bull Pasture, 3000 ft, 9 Aug 1979, *Bowers 1802*. Crestline of Ajo Mts above Middle Fork of Alamo Canyon, abundant, *Rutman 8 Oct 1999* (ORPI). Saddle between Boulder and Arch Canyons, rare, 3550 ft, 26 Oct 2003, *Rutman 2003106-2* (ORPI).

ARECACEAE – PALM FAMILY

Figure 4. Michael R. Kunzmann (left) and Peter S. Bennet, research scientists, Cooperative National Park Resources Studies Unit, University of Arizona, removing *Washingtonia filifera* at Quitobaquito, May 1982.

WASHINGTONIA FILIFERA (Linden ex André) H. Wendland de Barry
Fan palm. Figure 4.

Fan palms were surreptitiously planted at Quitobaquito twice in the 1980s. The first ones, removed in May 1982, were obviously nursery-grown since the roots showed that they were container-grown. Two additional small plants (*89-258*) were found in 1989 and these were also removed (Felger 1990: 71). Both species of *Washingtonia* are grown in adjacent Sonoyta. *Washingtonia filifera*, a widely cultivated fan palm, is native to desert oases in Arizona, Baja California, and California.

OP: Quitobaquito, two small plants growing together, estimated to be 2 or 3 years old, in alkaline soil below spring seeps to northeast of pond, 19 Jun 1989, *Felger 89-258* (ORPI 9667).

ASPARAGACEAE – ASPARAGUS FAMILY
(includes Agavaceae, Nolinaceae, Ruscaceae, and Themidaceae)

As presently constituted (APG III, Stevens 2001) this large, diverse, and unwieldy family includes a broad spectrum of growth forms in the flora area including cool-season perennial geophytes with bulbs (corms) and diverse rosette-forming perennials. Those of the flora area share the following features: Flowers 3-merous, radial, bisexual or unisexual and the plants dioecious. Tepals 6, petal-like and all similar, distinct or united basally. Stamens 6. Ovary inferior or superior; fruits dry and dehiscent (capsules) or fleshy and indehiscent; seeds 3 to many.

1. Leaves lasting more than one year, spinescent or not.

    2. Beargrasses; leaves not succulent and spinescent, the leaf tips frayed, fibrous; male and female flowers on separate plants ..... **Nolina**
    2. Leaves succulent and spinescent at least at the tip; flowers bisexual.

        3. Plants trunkless; leaf margins spinescent or not; flowers yellow, the stamens conspicuously longer than the perianth ..... **Agave**
        3. Trunk(s) evident; leaf margins without spines; flowers white, the stamens shorter than the perianth..... **Yucca**

1. Leaves and inflorescences herbaceous and appearing only during cool seasons and not persisting, unarmed.

    4. Leaves more than 8 mm wide, the margins wavy (crisped); flowers in racemes; corollas more than 4 cm wide or long, whitish ..... **Hesperocallis**
    4. Leaves to 1 cm wide, the margins entire; flowers in umbels; corollas less than 2 cm long or wide, bluish or lavender-pink.

        5. Bulbs (corms) solitary (one per plant) or few; rocky-gravelly soils of hills, mountains, or bajadas..... **Dichelostemma**
        5. Bulbs (cormlets) many in clusters; dunes and sand flats ..... **Triteleiopsis**

AGAVE – Century plant; *maguey, mescal*

Rosette-forming plants, long-lived, solitary or suckering, each rosette dying after flowering. Leaves succulent and tough, ending in a stout spine, and with parallel tough fibrous veins; margins entire or spinescent. Inflorescences relatively large, many-flowered, spicate (spike-like) or paniculate (branched). Tepals petal-like and united basally to form a nectar-containing tube. Ovary inferior. Stamens 6; anthers large and versatile (attached near the middle and swinging freely on the filament);

style and stamens much longer than the tepals. Fruits capsules (dry and dehiscent at maturity), with many flattened, black seeds.

The fossil specimens were mostly identified by Tony Burgess. His identifications are based in part on examination and comparisons of epidermal cell structure and stomatal patterns including their positions (e.g., sunken or not).

1. Leaves 7–9 cm wide at mid-length; the margins spiny; flowering stalks thick, usually more than 2.5 m tall, paniculate with horizontal branches ..... **Agave deserti**
1. Leaves 0.7–1.5 cm wide, the margins not spiny; flowering stalks slender, to 2.5 m tall, spicate or with short branches erect and close to the main axis.

2. Leaves 7–12 mm wide at mid-length, the margins with conspicuous, stringy fibers; flowering stalks not more than 2.5 m tall, slender and unbranched or branches erect and close to the main axis ..... **Agave schottii**
2. Leaves 15–30 mm wide at mid-length, the margins without fibers; inflorescences of slender panicles ..... **Agave × ajoensis**

Agave × ajoensis W.C. Hodgson
Ajo Mountain agave

Small century plants forming small colonies. Leaves green with entire margins. Flowers yellow. This sterile hybrid is known from only a few dozen "clones or plants" at higher elevation in the Ajo Mountains (Hodgson 1999, 2001a).

"*Agave* × *ajoensis* is of hybrid origin involving putative parents, *A. deserti* var. *simplex* of the subgenus *Agave* and *A. schottii* var. *schottii* of the subgenus *Littaea*. It is a triploid, having a chromosome number of $2n = 90$ (Pinkava et al. 1992). In the same area *A. deserti* var. *simplex* is a diploid ($2n = 60$) (Pinkava et al. 1992), while *A. schottii* var. *schottii* is a tetraploid race ($2n = 120$) (Pinkava et al. 1992). The narrowly racemose to subspicate inflorescence of *A.* × *ajoensis* is similar to other agaves suspected of being of hybrid origin involving hybridization between *Agave* subg. *Littaea* (with a spicate or rarely racemose inflorescence) and *Agave* subg. *Agave* (with a paniculate inflorescence)" (Hodgson 2001a: 414).

OP: Ajo Mts, infrequent on rocky slopes, with *A. schottii* var. *schottii*, *A. deserti*, etc., leaves of most clones heavily munched, 14 Apr 1987, *Hodgson 4478* (holotype, DES; isotype, ORPI); 14 Jun 1992, *Hodgson 6972* (ORPI).

Agave deserti Engelmann subsp. **simplex** Gentry
[*A. deserti* var. *simplex* (Gentry) W.C. Hodgson & Reveal]
Desert agave; *lechuguilla, mezcal*; 'a'ud. Figure 5.

Rosettes solitary or with a few offsets, and occasionally forming small colonies. Leaves 30–95 in number (larger plants), thick, dull glaucous gray-green, linear-lanceolate, often (30–)45–60 × 7–9 cm; marginal spines often 6–14 mm long, curved, dark red-brown, with age becoming gray, the terminal spine stout. Flowering stalks often 2.5–5 m tall, the inflorescences paniculate, the lateral, flower-bearing branches 8–30 cm long. Fresh flowers including the stamens 6–8 cm long, the tepals yellow, often reddish brown on the outer surfaces near the tip; anthers yellow. Capsules 3.3–6.2 cm long. Seeds 5.2–6.7 × 4–5 mm, D-shaped, the margins with a raised, irregularly fluted narrow wing. Flowering April–June; fruiting June and July. Wendy Hodgson noted that the flowers "smell like dirty socks" (*Hodgson 5766*), which is not surprising since bat-pollinated flowers often have a musty odor.

Figure 5A. *Agave deserti* subsp. *simplex*. Bull Pasture, Ajo Mountains, Organ Pipe Cactus NM, 24 September 2006, photo by Sue Ruthman

Widespread across the flora area, in mountains often to the summits, hills, and occasionally upper bajadas of granitic mountains in Cabeza Prieta and on the east side of Tinajas Altas Mountains *Agave deserti* has been at Tinajas Altas for at least 18,700 years The distribution of *A deserti* expanded during the wetter rainfall climates of glacial times and its range became fragmented in Holocene times

Subspecies *simplex* occurs in southwestern Arizona, southeastern California, and northwestern Sonora The two other subspecies are in southern California and Baja California

As in other places, agaves (subgenus *Agave)* served as major food resources and the leaves yielded fiber for cordage Sonoran Desert agaves provided one of the few significant wintertime sweets during traditional times (e g , Bell et al 1980, Castetter et al 1938, Felger & Moser 1985, Hodgson 2001b, Rea 1997, Betty Melvin in Zepeda 1985 54) Gentry (1982 379) stated that, "*Agave deserti* is among the more edible of the agaves " Plants showing signs of initiating a flowering stalk were selected, harvested, and trimmed to leave the centers, the "hearts," or "*cabezas*," which were baked on coals in pit ovens *Agave deserti* would have been harvested in late winter and early spring Emerging flower stalks were also pit-baked or cooked in coals Cooked agave hearts were sliced and eaten fresh or formed into cakes or other products that were dried and stored The flowers and seeds are also edible but probably were only a minor resource The leaf fiber was widely used to make cordage, burden basket nets, and sandals (Castetter et al 1938, Betty Melvin in Zepeda 1985 54) "They would roast the agave, roast it under coals and eat it They also pound out the fibers and turned it into rope" (Betty Melvin in Zepeda 1985 54)

Figure 5B *Agave deserti* subsp *simplex* Bull Pasture, 24 September 2006, photo by Sue Rutman

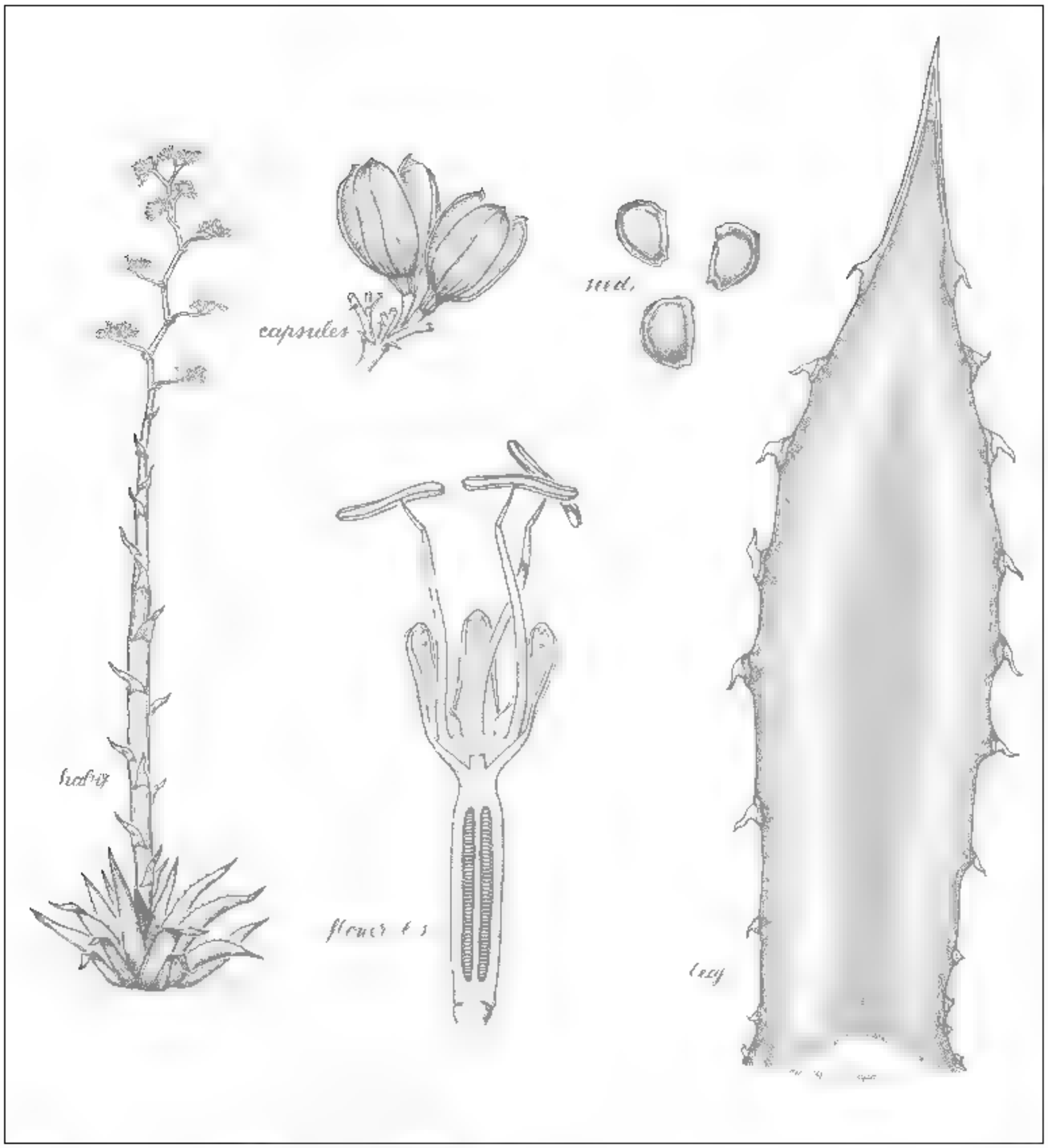

Figure 5C. *Agave deserti* subsp. *simplex*. Illustration by Wendy C. Hodgson.

OP: Ajo Mts, 3000 ft, *Minnesota* (ORPI). 18 Mile Drive, *West 27 May 1962*. Bull Pasture, *n.* 30, flowering stalk 5 m long, glaucous, 17 May 1989, *Baker 7759* (ASU). Top of ridge just W of Bull Pasture, 3200 ft, *n.* 30, 17 May 1989, *Baker 7759* (ASU, 2 sheets, ORPI). Bull Pasture, 3000 ft, 4 Jun 1990, *Hoagson* 5765, 5766 (DFS, ORPI). Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger* (observation). †Alamo Canyon, leaf fragment, 1150 to 32,000 ybp (7 samples). †Montezuma's Head, leaf fragments, 13,500 to 21,840 ybp (4 samples). †Twin Peaks in Puerto Blanco Mts, 14,120 ± 260 ybp (common, Van Devender 1987).

CP: Tule Mts, Mexican boundary, 11 Feb 1894, *Mearns 305* (US, two leaves, one has unusually large spines but within range of variation, also cited by Gentry 1982). Near a sheep tank in Cabeza Prieta Mts, 3 May 1964, *Gentry 20590* (ARIZ). 2.6 mi E of Tule Well on Camino del Diablo,

1200 ft, plain at foot of granitic mountain or hills, inflorescence 5 m tall, 20 laterals, 19 Jun 1976, *Engard 952* (ARIZ, DES) 5 8 mi W of Tule Well on Camino del Diablo, 1180 ft, 19 Jun 1976, *Engard 953* (ARIZ, DES) Childs Mt, 2240 ft, 9 Apr 1993, *Felger* (observation) Sierra Pinta, summit, 15 Nov 2003, *James Cain* (photo)

TA Tinajas Altas 20 Nov 1913, *Goldman 2310* (US, also cited by Gentry 1982 412), South canyon above Tinajas Altas Tanks, 1920 ft, 20 Jun 1976, *Engard 956* (ARIZ, DES), 1300 ft, 26 Apr 86, *Van Devender 86-142* Between Camino del Diablo and Borrego Canyon, 4 Feb 1990, *Felger 90-19* †Tinajas Altas, leaf fragments (epidermis), prickles, seeds, 1230 to 18,700 ybp (17 samples)

Agave schottii Engelmann var **schottii**
Shin-dagger, *amolillo*, utko je j Figure 6

Small, profusely suckering agaves in subgenus *Littaea* Leaves linear, mostly 20 40 × 1 2 5 cm, dull green, the margins entire with stringy fibers, the leaf tip with a stout spine Flowering stalks slender, often 1 5 2 5 m tall, spicate or with short, slender, appressed branches Flowers 3 5 cm long, the perianth yellow Capsules short-pedicellate, obovoid, 1 2 cm long, the tip rounded to beaked Seeds 3 3 5 mm wide Flowering mostly in May, the fruits ripen in early summer, and sometimes as late as October

Ajo Mountains from middle elevation to the summit *Agave schottii* thrives in flat areas with shallow soil It also grows on slopes but it does not achieve the infamous patches that render hiking in a straight line impossible, such as at Bull Pasture It occurs on a northeast-facing slope at a cliff base at about 3000 ft along the trail to Bull Pasture, mixed with other species that normally occur at higher elevations Also in the Diablo Mountains where it covers the relatively flat top of the mountain

Figure 6A *Agave schottii* var *schottii* Bull Pasture, Ajo Mountains, 24 September 2006, photo by Sue Rutman

Figures 6B and 6C *Agave schottii* var *schottii* Bull Pasture, 22 October 2006, photos by Sue Rutman

Eastward and northward from the flora area in mountains of southern and central Arizona, southwestern New Mexico, and northern Sonora. Variety *treleasei* occurs in the Catalina Mountains of southeastern Arizona and seems to be of hybrid origin (Reveal & Hodgson 2002)

Seris made arrow shafts from the flowering stalks, and the "leaves were crushed in a container and water added. The resulting foamy mixture was considered excellent for washing hair. It was said to soften the hair, as well as make it grow long" (Felger & Moser 1985: 224). The leaves were widely used by Tohono O'odham and others for soap, including clothes washing (Castetter & Bell 1942, Castetter et al. 1938, Felger & Moser 1985, Gentry 1982). Castetter and Bell (1942) reported that the Tohono O'odham pit roasted and ate this agave, but it was not likely used for food, or at least not a significant food resource since it is "sapogenous and relatively unpalatable" (Gentry 1982: 197).

The flowers are very sweet smelling, producing fragrance and nectar diurnally. The most effective pollinators are probably sphinx moths at night, although daytime flower visitors and pollinators include honeybees, bumblebees, and hummingbirds (Slausen 2001; Trame et al. 1995). Bats are unlikely to be significant pollinators (Slausen 2001).

OP: Bull Pasture, *Fouts 1 May 1948* (ORPI). Diablo Mts, E-facing slope, 0.15 mi ESE of peak, with *Agave deserti*, *Fouquieria*, *Stenocereus*, *Vauquelinia*, 11 Mar 1988, *DeLamater 4959* (DES). Bull Pasture Trail, 3000 ft, *Juniperus*, *Agave deserti*, *Stenocereus*, 27 Apr 1988, *Hodgson 4985* (DES). Diablo Mts, with *Fouquieria*, *Encelia*, *Cercidium*, *Ephedra*, etc., 1 Mar 1989, *Hodgson 5418* (ASU, ORPI). Bull Pasture, *n* 60, 3200 ft, 17 May 1989, *Baker 7754, 7756, 7758* (ASU, ORPI).

Dichelostemma capitatum (Bentham) Alph. Wood subsp. **pauciflorum** (Torrey) Keator
[*D. pulchellum* (Salisbury) A. Heller var. *pauciflorum* (Torrey) Hoover; *Brodiaea capitata* Bentham var. *pauciflora* Torrey]
Blue dicks, wild hyacinth; *coberia, cobena, ajo blanco*; ha:d. Figure 7.

Herbaceous perennials from small and rather deeply buried fibrous corms ("bulbs") often 1.8 2 cm long. Leaves slender (linear) with a mild onion-like flavor, 5 mm wide, the green (above-ground) portion often 27 32+ cm long, with a dry, dead, curled tip often 8 14 cm long. Leaves mostly U-shaped in cross section and in drying conditions the leaf partially or perhaps fully "closes" so that the margins touch, forming a functionally terete leaf, thereby greatly reducing the exposed surface area. Growing and flowering in winter and spring. Flower stalks leafless, often 25 50 cm tall; flowers in umbellate clusters of at least (2) 3 12 flowers subtended by spathe-like bracts. Flowers about 1.5 2 cm wide, pinkish or violet-blue and attractive. Perianth of 6 tepals united into a short, basal tube, the perianth lobes about 1 cm long, and with 6 appendages arising from the base of the perianth lobes; the appendages upright, taller than the stamens, and forming a corona. Stamens 6, fertile, in 2 alternating sets of 3; anthers smaller on outer 3 stamens and larger on inner stamens. Ovary superior. Seeds angled, blackish, several or more in 3-angled, thin-walled capsules.

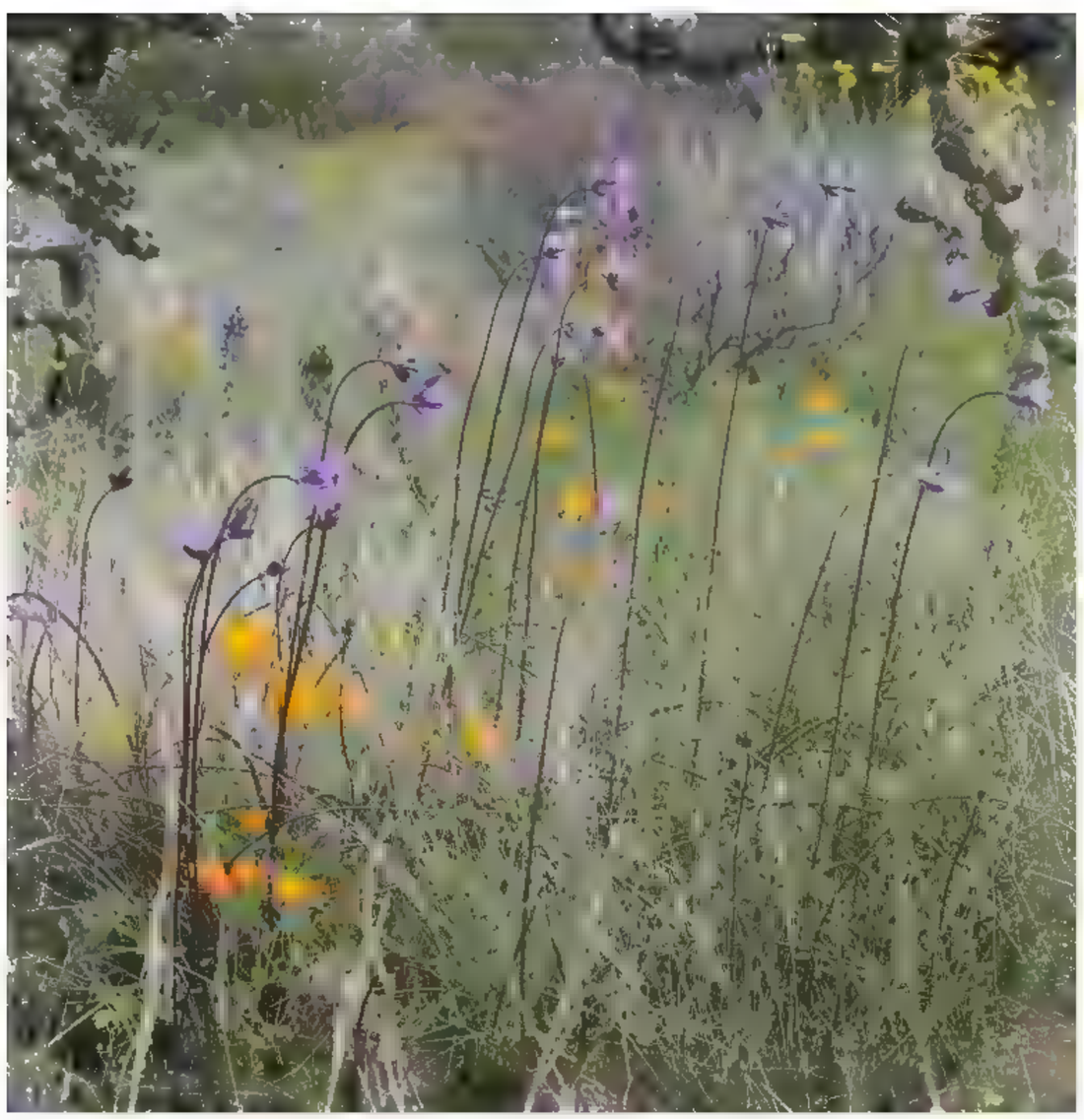

Figure 7A. *Dichelostemma capitatum* subsp. *pauciflorum*. Coffeepot Mountain area, Sauceda Mountains, Pima Co., 27 Feb 2005; photo by Sue Rutman.

Figure 7B. *Dichelostemma capitatum* subsp. *pauciflorum*. Coffeepot Mountain area, Sauceda Mountains, 27 Feb 2005, photo by Sue Rutman

Widespread in Organ Pipe and in the eastern part of Cabeza Prieta in the Agua Dulce and Growler Mountains, Arizona Upland mostly in rocky areas on mountains and hills, and upper bajadas. Especially common seasonally at higher elevations in the Ajo Mountains. Often growing through small shrubs that provide support for the flowering stalks and likely give protection from herbivores for the developing shoots. Not seen in the more arid areas of Organ Pipe such as the southwestern part of the Monument.

Two variable subspecies: subsp. *pauciflorum* in northeastern Baja California, southeastern California, southern Nevada, Arizona, southwestern New Mexico, southwestern Utah, northern Sonora, and probably northeastern Chihuahua, subsp. *capitatum* from Oregon to the Pacific side of northern Baja California Sur.

The fresh flowers are edible and small corms are edible fresh or cooked, but rather tasteless (Rea 1997). Castetter and Underhill (1935: 18) said the bulbs are unpleasant tasting but were "eaten largely because they appear in early spring, before other crops are ready."

OP Alamo Canyon, 2500 ft, Nichol, 14 Mar 1939, ORPI, *Tinkham Apr 1942*. Growler Mts., 18 Mar 1944, *Clark 11399*, ORPI). W of Dripping Spring, 26 Mar 1965, *Ranzoni 3312*, ORPI). Arch Canyon, 5 Apr 1978, *Bowers 11776*, ORPI. Trail from The Cones to Mount Ajo, 3940 ft, 10 Apr 2005, *Felger 05-254*.

CP 1 mi. NE of Agua Dulce Pass, Simmons 1966. Lower slopes of Growler Mountain NE of Charlie Bell Pass, tributaries to Daniels Arroyo, 1200 ft, 20 Mar 1992, *Crawford, Ayers*, ASC. Between Daniels Arroyo and Charlie Bell Pass, "common, about 40 cm tall, flowers pale purple", 26 Mar 1993, *Dave Turner* observation. E side of Charlie Bell Pass, see *Allium macropetalum*, Harian 449.

Hesperocallis undulata A. Gray

Ajo lily, desert lily, *ajo silvestre*, asos. Figure 8

Herbaceous perennials from a single, deeply set rounded bulb about 4-6 cm long, and especially in sandy soil forming long, thick and succulent roots below the bulb (these roots probably seasonal). Above-ground portion of leaves 20-45 × 1-1.5 (2) cm, thickish, glaucous bluish-green, the margins wavy or crisped. Flower stalks erect, stout, with a few reduced leaves below and bracts above, unbranched often (20) 30-60+ cm tall, or sometimes with 1 to several branches and reaching 150-180 cm tall in favorable seasons in sandy soil. Flowers fragrant, observed opening in late afternoon, closing with the heat of next morning, 6-8 cm wide when fully open. Tepals 6, united below into a tube, each tepals 6.4-7.5 cm long including the tube, 1-1.2 cm wide, white inside with a greenish purple mid-stripe outside. Stamens 6, about as long as the tepals, the anthers 11-13 mm long and yellow. Ovary superior; style slightly longer than tepals. Stigma, style, and filaments white. Fruits of many-seeded capsules, the seeds flat, about 5 mm wide. Growing during winter and spring, flowering (November-) February-May depending on rainfall.

Figure 8A. *Hesperocallis undulata*. Dunes south of Sierra Blanca, Reserva de la Biosfera El Pinacate y El Gran Desierto, Sonora, 20 February 2005, photo by Steve Rutman.

Figure 8B. *Hesperocallis undulata*, Mohawk Dunes, Goldwater Range, 17 January 2005, photo by Steve Rutman

Widespread, often in locally dense populations, and usually very common during wetter years, especially on deeper, mostly sandy soils; dunes, valley floors, bajadas, desert pavements, and also soil pockets in rocky areas such as low hills. Rodents, lagomorphs, and other small mammals dig for the bulbs.

Southwestern Arizona, southeastern California, southern Nevada, northeastern Baja California, and northwestern Sonora.

The relatively large bulbs were baked or boiled and also eaten fresh, probably in spring (Castetter & Bell 1951; Bean & Saubel 1972; Hodgson 2001b), but are rather slimy when fresh (also see Rea 1997).

OP Growler Mts, *Crooks 31 Mar 1937* Near N-middle entrance [of the Monument], 25 Mar 1941, *McDougall 37* Ajo Valley, *Nichol 26 Mar 1939* (ORPI) Puerto Blanco Drive 0 5 mi [E] from Hwy 85, 11 Mar 1973, *Shervanick 751* (RSA) 10 mi N of junction Puerto Blanco Drive and Bates Well Road, sandy wash, 30 Mar 1978, *Bowers 1117* 3 mi E of Bates Well, *Beale 4 Apr 1987* (ORPI)

CP 4 mi W of Papago Well, 15 Apr 1941, *Benson 10774a* (RSA) W boundary of Cabeza Prieta Game Reserve with Camino del Diablo, long roots below the bulb thick and succulent, 18 Apr1976, *Engard 918* (DES) Pinta Sands 10 Apr 1978, *Reeves 6783* (RSA) San Cristobal Wash, 20 Mar 1992, *Harlan 17* 1 mi N of Tule Well, 20 Mar 1992, *Yeatts 3241* (CAB)

TA Coyote Water, 21 Feb 2005, *Felger 05-119*

††Hesperoyucca whipplei (Torrey) Baker, sensu lato
[*Yucca whipplei* Torrey, sensu lato]
Spanish bayonet

Agave-like plants forming rosettes to about 1 + m wide; leaves numerous, slender, and with a sharp-spined tip. Flowering stalk massive, probably 1.5 3 m tall with hundreds of large white flowers in spring, the rosette (plant if solitary) dying after flowering and fruiting.

Hesperoyucca was common in the Puerto Blanco Mountains about 14,000 years ago (Van Devender 1987) and abundant in Tinajas Altas samples more than 11,000 years ago (Felger et al. 2012). *Hesperoyucca* was widespread across the Sonoran Desert in early Ice Age times (Van Devender 1990, 2007). It is missing from most Sonoran Desert middle and late Holocene midden samples, indicating that the main range reduction was due to drying climatic conditions. The fossils may be one or more of the three present-day species

A small, disjunct population presently occurs on the north side of the granitic Sierra del Viejo a short distance south of the Tinajas Altas Mountains in adjacent Sonora (Felger 2000; Felger et al. 2007). These plants are large and monocarpic (the rosette is solitary and does not produce offsets). It is strange that this *Hesperoyucca* is not known from similar granitic mountains in nearby southwestern Arizona. These plants resemble *Hesperoyucca whipplei* sensu stricto in size and *H. newberryi* (McKelvey) Clarey in being monocarpic, but critical taxonomic relationship remains to be determined. The present-day distribution of *H. whipplei* is largely west of the desert in California and Baja California; *H. peninsularis* (McKelvey) Clarey occurs in desert areas in central Baja California; and *H. newberryi* is restricted to the Grand Canyon region in northwestern Arizona (Clarey 2001; Turner et al. 1995).

Perhaps bighorn sheep and or perhaps harvesting by prehistoric people had an impact on the extirpation of *Hesperoyucca* in the flora area and other seemingly suitable areas (see below; also Felger 2007 and Felger et al. 2013a). The nearby population on the Sierra del Viejo west of the Pinacate range (Felger 2000; Turner et al. 1995) is a place where there are no waterholes (*see* Broyles et al. 2007) and therefore probably are less frequented by bighorn sheep and prehistoric people than in

the Tinajas Altas Mountains (see Broyles et al. 2012). Bighorn eat the inflorescences when they can reach them (see *Felger 85-719*, below). In other regions *Hesperoyucca* "hearts" or "*cabezas*" and young, emerging flowering stalks were pit-baked or roasted like those of agaves, and the flowers and seeds were also eaten (Barrows 1900; Felger 2007; Hodgson 2001b; Meigs 1939). Harvesting the "hearts" and emerging flowering stalk would prevent reproduction.

OP †Twin Peaks in the Puerto Blanco Mts, 14,120 ± 260 ybp (common, Van Devender 1987)
TA †Tinajas Altas, leaf fragments, 11,040, 18,700, & >37,000 ybp
Sonora Sierra del Viejo (Sierra Los Alacranes on Mina del Desierto map), 50 km W of Los Vidrios on Mex Hwy 2 (16 km E of El Sahuaro on Hwy 2, or 108 km W of Sonoyta), vicinity of 32°09'N, 113°56'W, N side of steep granitic mountain, desertscrub Plants solitary, 100+ leaves per plant, leaves glaucous, the younger leaves with red proximal to dark brown just below the spine, the spine tip light brown, the red fading on older leaves, leaves diamond-shaped in x-section, keeled conspicuously below [abaxially] and slightly less so above, the margin yellow-green (like that of *Yucca rigida*) Inflorescence stalks thick, 10 cm diameter at base, 2 m tall Bighorn ate lower half of inflorescence branches where they could reach from adjacent cliff, ripe fruit green in color, seeds black, 14 May 1985, *Felger 85-719* (ARIZ, ASU [I noted fresh bighorn scats and there were no other animals at that place large enough to reach the inflorescence branches RSF, photos in Felger 2000 and Felger & Broyles 2007])

Nolina – Beargrass

Large plants with woody caudices or trunks. Leaves flexible, often to about 1 m long, linear, the margins minutely serrated or essentially entire, the tips brush-like with frayed fibers. Male and female flowers on separate plants, the inflorescences of large, compound panicles. Flowers numerous, small, radial, and white, with 6 tepals in 2 whorls. Stamens short, reduced in female flowers. Ovary superior, reduced in male flowers. Fruits of 3-lobed capsules, papery, and relatively small. Seeds 3 per fruit, rounded, brown to pale gray.

1. Plants producing a well-formed trunk; leaves 15–30 mm wide; mountains in Cabeza Prieta and Tinajas Altas ..... **Nolina bigelovii**
1. Plants trunkless; leaves 6–12 mm wide; Ajo Mountains ..... **Nolina microcarpa**

Nolina bigelovii (Torrey) S. Watson
Desert tree-beargrass; moho. Figure 9.

Yucca-like plants with a thick woody trunk 0.5–3 (6) m tall, unbranched or sometimes few-branched, the bark thick and with age becoming checkered. Leaves linear, to 1+ m × 1.5–3 cm, flat and flexible, light green; margins minutely serrated but appearing entire, soon peeling away in persistent fibrous strips; dead leaves long-persistent. Flowering stalks 1.5–3 m tall, much-branched and densely flowered. Pedicels slender, the tepals 2.5–3 mm long. Female flowers white with a pale green ovary; male flowers white with yellow anthers. Capsules 8–10 mm wide and about as long, papery, and 3-winged. Seeds 3.5–4 mm long, oblong-ovoid, pale yellow-brown to tan. Flowering (March–) May and June; fruits ripening June and July. Flowers visited by numerous insects including honeybees and large spider wasps, the inflorescences often blowing in the hot summer wind, the bees and wasps clinging and crawling all over the flowers.

Rocky arroyos, cliffs, and slopes to summits of granitic hills and mountains in the western part of Cabeza Prieta including Cabeza Prieta, Sierra Pinta, and Tule Mountains, and in the Tinajas Altas Mountains where it has been present for more than 37,000 years.

Spectacularly tall nolinas occur along the bottom of Frontera Canyon, a large, rugged, interior canyon at the south end of the Tinajas Altas Mountains. Some of these giants have trunks 4–5 m tall, and one fallen, dead nolina had a trunk more than 19.7 ft (6 m) long (measured 18 Mar 1998; Felger et al. 2012). Similar giants were seen on the higher, east-facing slopes above the Tinajas Altas

Figure 9A. *Nolina bigelovii.* Frontera Canyon, Tinajas Altas Mountains, 3 March 2013; photo by Jim Malusa.

Figure 9B. *Nolina bigelovii.* Tinajas Altas Mountains, west side, view south into Mexico. 3 March 2012; photo by Jim Malusa.

waterholes Leaves forming the crowns of these giants were much shorter than the usually, "normal-size" plants Simmons (1966) reports that the leaves are eaten by bighorn sheep

Western Arizona, southern Nevada, southeastern California, northeastern Baja California, and northwestern Sonora

The young flower stalks were pit-baked by the Cahuillas (Bean & Saubel 1972) The seeds are presumably edible and the leaves would be a handy source of tough fiber, but reliable evidence for such uses are lacking for *N. bigelovii*, but well documented for similar species in the Southwest (e g , Moreman 2003)

CP Tule Desert W of Monument 180, Mex boundary line, 11 Feb 1894, *Mearns 2797* (CAS/DS) Tule Tank Canyon, *Tinkham 14 Apr 1947*. S end of Cabeza Prieta Mts, 29 Feb 1976, *McManus 689* Buckhorn Tank, 14 Jun 1992, *Felger 92-601* Heart Tank, 14 Jun 1992, *Felger 92-592a, 92-592b*

TA Tinajas Altas, 21 Mar 1933, *Shreve 6233* Tinajas Mountains, major tinajas and camping area, 390 m, 11 Feb 1993, *Hodgson 6975* (DES) Frontera Canyon, 18 Mar 1998, *Felger* (photos, Felger et al 2012) †Tinajas Altas, leaf fragments, 4010 to 18,700 (16 samples), & ~37,000 ybp

Nolina microcarpa S Watson
Beargrass, *sacahuiste*, moho Figure 10

Robust perennials with a thick, mostly underground woody caudex, with multiple rosettes Leaves slender, rather thick and grooved (channeled) above, rather firm but flexible, often to about 1 m long and 1 cm wide, with minutely serrate edges that can cut like a knife, leaf tips of frayed fibers Inflorescences conspicuously taller than the leaves Flowers with white tepals 1 5–3 mm long, male flowers with yellow anthers, female flowers with green ovaries Capsules thin-walled, inflated, 4 6 mm long Seeds compressed, 2 2 3 5 mm wide Flowering late spring or early summer

Figure 10A *Nolina microcarpa* Middle fork of Alamo Canyon, Ajo Mountains, 26 Mar 2005, photo by Sue Rutman

Figure 10B. *Nolina microcarpa*. Tip of young staminate inflorescence, Silver City, Grant Co., New Mexico, 26 October 2009; photo by Russ Kleinman (gilaflora.com).

Figure 10C. *Nolina microcarpa*. Staminate flowers, Acklin Hill, Pinos Altos Range, Grant Co., 24 May 2009; photo by Russ Kleinman (gilaflora.com).

Common in the Ajo Mountains above approximately 3000 ft and especially near the crestline. It was in the Ajo Mountains at least from 14,500 to 29,000 years ago when it occurred at lower elevations than at present. The nearest population is at higher elevation in the Sand Tank Mountains.

Widespread in Arizona except the arid southwestern corner, western New Mexico, northern and eastern Sonora, Chihuahua, and Durango.

The leaves have long been used by the Tohono O'odham for making baskets, often in combination with *Yucca elata* leaf strips (Castetter & Bell 1942). The young flower stalks were baked in coals and the flowers and seeds were ground and cooked (Castetter 1935, Hodgson 2001b; Yanovsky 1936).

OP: Boulder Canyon, *Steenbergh 24 May 1962* (ORPI), 3000 ft, 3 May 1978, *Bowers 1296* (ORPI). †Alamo Canyon, leaf fragments, 14,500 & 29,110 ybp.

Triteleiopsis palmeri (S. Watson) Hoover
[*Brodiaea palmeri* S. Watson]
Blue sand-lily. Figure 11.

Figure 11A. *Triteleiopsis palmeri*. Sand flats south of Sierra Blanca, Sonora, 20 Feb 2005, photo by Sue Rutman.

Figure 11B *Triteleiopsis palmeri* Anonymous ASU SEINet

Bulbs small and clustered, the tiny cormlets (bulblets produced on top of the previous year's bulbs and in axils at leaf bases propagating mostly? by bulblets. Leaf margins entire. Leaves of 2 kinds: first leaves of season green, stringy (linear, filiform, limp, and prostrate on the ground, reaching 32–53 cm long; later leaves appearing with flower stalks, glaucous, erect, ascending, held well above the ground, the blades to 1 cm wide, sometimes becoming moderately fleshy, usually 15–30 cm long, somewhat thickened like the leaf of a leek, wide and clasping the axillary cormlets. Flowers several to many in terminal umbels on leafless stalks 35–60 cm tall, the upper part of the stalk often blue. Flowers attractive, deep blue, 1.5–1.8 cm wide on slender pedicels. Tepals 6, united below into a tube. Ovary superior. Pedicels, tepals, filaments and ovary blue-purple, the anthers nearly white before dehiscence, the hypanthium at summit of the tube with a dark purple-blue ring

outlined with a white ring, the hypanthium and filaments forming a somewhat scalloped collar with holes through which one can see the lighter-colored tube that appears white in the sun and probably functions as a nectar guide. Seeds blackish and flat. Growing in winter spring; flowering February mid-May.

Sand flats and dunes on the Pinta Sands and vicinity southward to the Sonora border and sand areas within the Pinacate Lava Flow; locally abundant in years of sufficient rain. Also near the western boundary of the Tinajas Altas region.

The blue sand-lily occurs on sand soils in the Gran Desierto in Sonora southward to Isla Tiburón and the Baja California Peninsula, but has limited distribution in the USA where it is known only from Yuma County in Arizona.

The small cormlets (bulblets) are tasty, eaten fresh or cooked (Felger 2007; Felger & Moser 1985).

CP Sand near Border Monument 182, *Monson 7 Feb 1958* Sandy area within Pinacate Lava Flow, 11 Apr 1978, *Reeves 6804* (DES) Pinta Sands, 17 Apr 1983, *Hodgson 2092* (DES) Camino del Diablo, 1 1 mile N of Mexico, Pinta Sands, 10 Apr 1993, *Felger 93-384*

Yuma Co Butler Mts, *Van Devender 27 Mar 1983* Near Border Monument 198, 13 Apr 1993, *Morrison 73* (ASU)

YUCCA

Shrub-sized plants with thick stems (those in the flora area). Leaves thick, succulent, tough-fibrous, and spine-tipped, the margins with stringy, shredding fibers. Inflorescences terminal, branched, and large; flowers white, large and showy, with 6 rather thick, waxy tepals. Fruits fleshy and indehiscent, or dry and dehiscent (capsules). Seeds flattened, D-shaped, blackish, and numerous.

1. Leaves 3 cm or more wide; flowering stalks less than twice as long as the leaves; fruits indehiscent and fleshy ..... **Yucca baccata**
1. Leaves less than 2 cm wide; flowers stalks more than 4 times as long as the leaves; fruits dehiscent and dry ..... **Yucca elata**

Yucca baccata Torrey var. **brevifolia** L.D. Benson & Darrow
[*Y. arizonica* McKelvey]
Banana yucca; *dátil*; howij. Figure 12.

Often forming colonies with several thick trunks 1 1.5 (2) m tall, branching from the base and also near the crown. Leaves 60 80 × 3 4 cm, firm and thick, light green to often yellow-green, the margins with coarse, often brown, fibrous threads. Flowering stalks slightly shorter to about one-third longer than the leaves, with glabrous branches. Flowers pedicelled, nodding to pendent, not opening wide (or opening wider at night?), the tepals white and 6 7+ cm long, the flowering ovary slender, 4 4.5 cm long. Fruits green, highly variable in size, probably mostly 10 18 × 5 7 cm, baccate (more or less cylindric with rounded ends), pendent, indehiscent, and fleshy, the pulp sweet and edible when ripe. Seeds more or less ovoid to D-shaped, about 1 cm wide. Flowering March and April; fruits ripening in early summer. The flowers open wider at night and partially close during the day.

Figure 12A. *Yucca baccata.* Sand Tank Mountains near head of Sand Tank Wash, Maricopa Co., 18 Feb 2006; photo by Sue Rutman.

Figure 12B. *Yucca baccata.* Bull Pasture, Ajo Mountains, Organ Pipe Cactus NM, 10 April 2005; photo by Sue Rutman.

Figure 12C *Yucca baccata* Fossil Spring Canyon, Coconino National Forest, Coconino Co., Arizona, 25 April 2013, photo by Wendy Hodgson

Figure 12D *Yucca baccata* Bisected fruit, proximal end at bottom, Rocky Canyon, Grant Co., New Mexico, 31 July 2009, photo by Russ Kleinman (gilaflora com)

Common at higher elevations in the Ajo Mountains, often with *Vauquelinia*, *Juniperus*, *Opuntia chlorotica*, *Nolina microcarpa*, and perennial grasses. This species grew at the base of the Ajo Mountains until at least 9600 years ago.

Variety *brevifolia* is widely distributed in mountains eastward from the Ajo Mountains in southern Arizona to southwestern New Mexico, northern Sonora, and northwestern Chihuahua. It is replaced northward by var. *baccata*, which extends into southern Utah.

This large yucca provided significant food resources in the Tohono O'odham and Pima regions. Castetter and Underhill (1935) report that O'odham people made expeditions to the mountains to collect the large, fleshy fruits. The fruits were often pit-baked. Young flower stalks, flowers, and seeds were variously cooked, and the seeds were often stored. The fruit pulp, eaten fresh or cooked, was commonly made into cakes and stored for future use, and was sometimes traded with neighboring people (Bell & Castetter 1941; Hodgson 2001b; Rea 1997). The fleshy fruit pulp becomes sweet as it ages, even when mushy and looking spoiled. The flowers are most certainly not edible fresh, and most references to the flowers in southern or southwestern Arizona being used for food probably refer to *Y. elata* rather than the banana yucca. The dried plants, especially the roots, were made into soap and shampoo, and the leaves yielded cordage (Bell & Castetter 1941).

OP Ajo Mts, 3000 ft, *Nichol 27 Apr 1939* (ORPI) Arch Canyon, steep slope, 3300 ft, 3 May 1978, *Bowers 1297* (ORPI) Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-278* Variety not certain †Alamo Canyon, leaf fragments, 9570 & 14,500 ybp.

††**Yucca brevifolia** Engelmann
Western Joshua tree
and or
Yucca jaegeriana (McKelvey) L.W. Lenz
[Y. *brevifolia* var. *jaegeriana* McKelvey]
Eastern Joshua tree

The fossils are either one or both of the two Joshua tree species and were common in the flora area until about 11,000 years ago. These unique trees are emblematic of the Mohave Desert although they also range into adjacent vegetation (Lenz 2007). Joshua Tree National Park in southern California is the nearest present-day population for *Y. brevifolia* and west-central Arizona is nearest for *Y. jaegeriana*. *Yucca brevifolia* occurs in southern California and southern Nevada, generally west of the range of *Y. jaegeriana*, which is found in southern Nevada, southeastern California, west-central and northwestern Arizona, and the southwestern corner of Utah (Lenz 2007). Lenz provides compelling evidence for recognizing the western and eastern Joshua trees as distinct species.

OP †Alamo Canyon, leaf fragments, seeds, 29,110 ybp Montezuma's Head, leaf fragments, seeds, 13,500 to 21,840 ybp (4 samples) †Twin Peaks in the Puerto Blanco Mts, 14,120 ± 260 ybp (very common, Van Devender 1987)

TA †Tinajas Altas, leaf fragments, 11,040, 18,700, & ~37,000 ybp (abundant in these samples)

Yucca elata Engelmann var. **elata**
Soap-tree yucca; *palmilla*

Trunk single or several-branched, to 2+ m tall, clothed in persistent, dry leaves. Leaves numerous, flexible, narrowly linear, mostly 40 70 × 1 1.5 cm. Leaf margins with thread-like white fibers. Flowering stalks often 2+ m tall. Flowers white, opening wide at night, partially closing the next day, with petal-like tepals 4–7 cm long; flowering in late spring and early summer. Fruits of dry capsules. Seeds flattened, D-shaped, blackish, and numerous.

This tall, elegant yucca occurs at or near the northeastern margin of Organ Pipe CNM. A photo from the 1940s in Gunsight Wash, near the northeastern margin of Organ Pipe, shows a plant with a single trunk about 2 m tall plus the flowering stalk (ORPI photo #186, with William Supernaugh). Jim Malusa found this yucca near the northern boundary of Organ Pipe on BLM land in the valley east of the Growler Mountains and west of Highway 85.

Yucca elata in Arizona generally occurs east and northward of the flora area. Variety *elata* is widespread from Arizona to Texas and also occurs in northeastern Sonora, Chihuahua, and Coahuila, in desert and grassland, and sometimes into pinyon-juniper woodland. Variety *elata* is replaced northward in Arizona by var. *verdiensis* (McKelvey) Reveal.

The Tohono O'odham fashion basketry splints from the slender, flexible leaves for weaving into modern artistic baskets, often in combination with beargrass (*Nolina microcarpa*) and devil's claw fibers (*Proboscidea parviflora*). Young flower stalks, flowers, and sometimes the seeds served as food resources. The flowers are edible and not excessively bitter like those of *Y. baccata*. The leaves have been used as cordage and the roots for soap and shampoo (Bell & Castetter 1941).

COMMELINACEAE—Spiderwort Family

Commelina erecta Linnaeus
White-mouth dayflower. Figure 13.

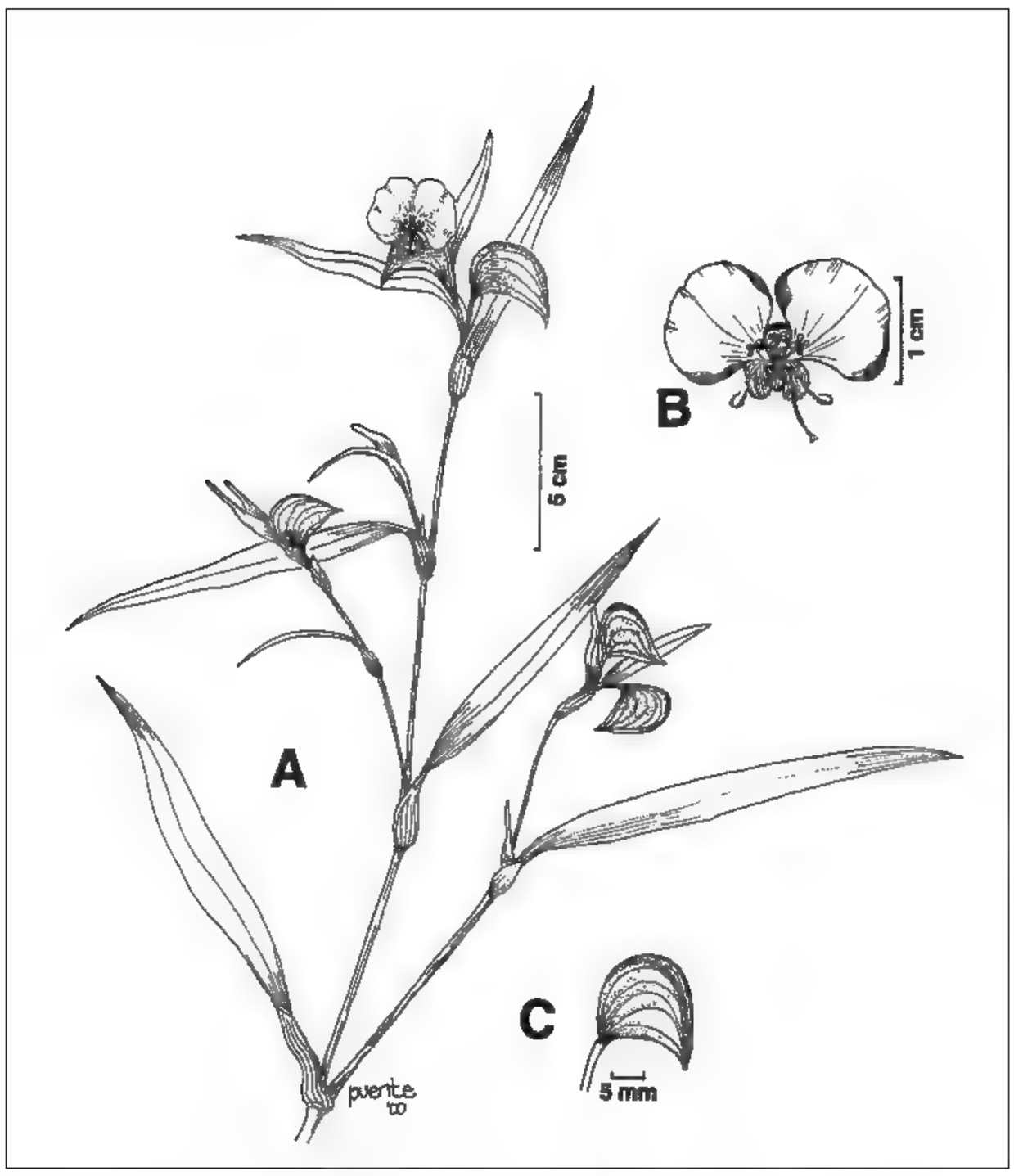

Figure 13A. *Commelina erecta*. Las Guijas Mountains, Pima Co., 1 September 1982. a, habit, b, flower, c, bract with margin fused at the base. Illustration by Raul Puente, based on *Mittleman 312* (ASU, Puente & Faden 2001).

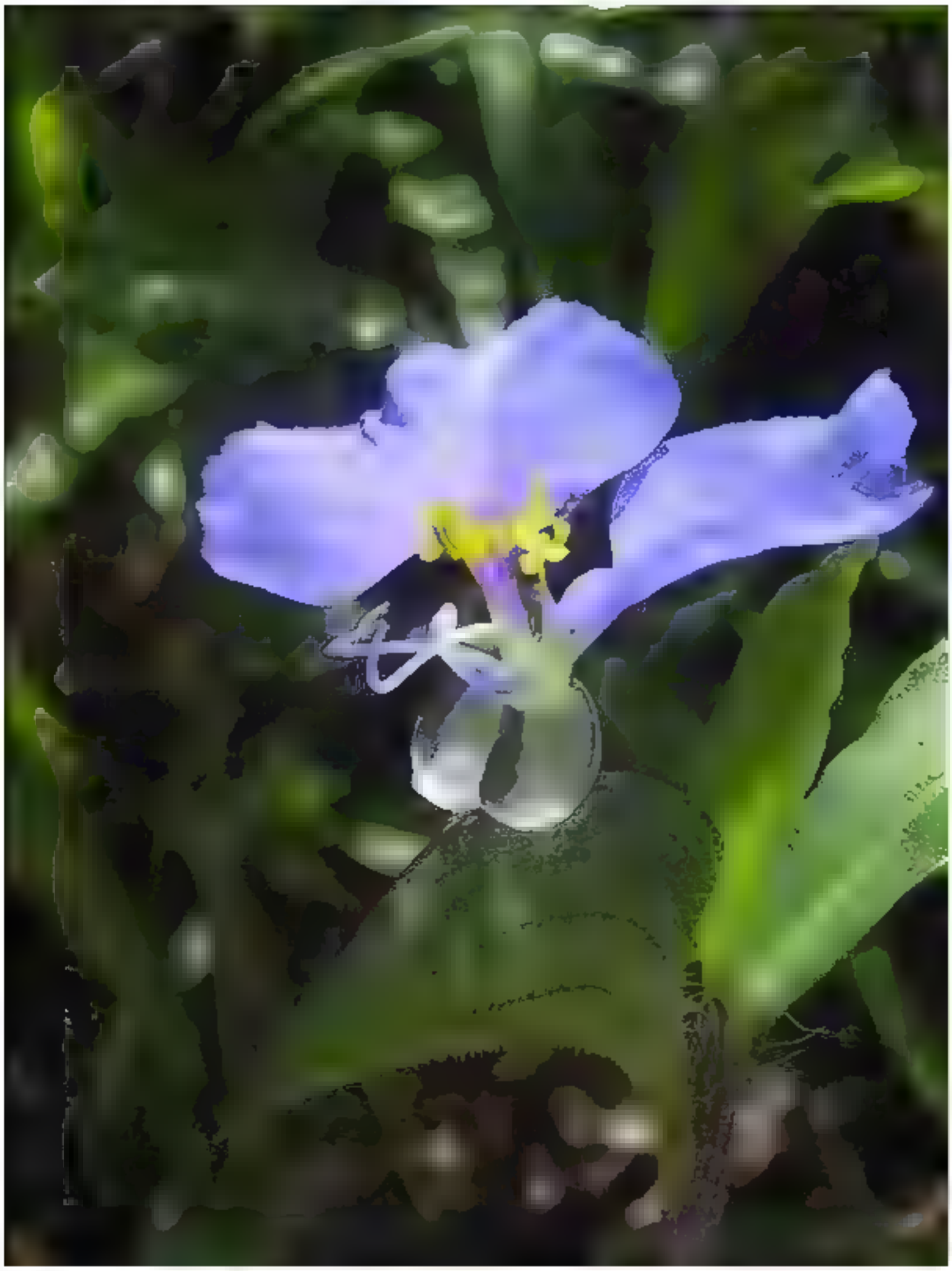

Figure 13B. *Commelina erecta*. Florida Mountains, Luna Co., New Mexico, 2 September 2008, photo by Gene Jercinovic.

Herbaceous perennials with a cluster of thick, succulent roots. Stems upright, few to many branched. Leaves alternate, the lower and larger leaves with a basal sheath enclosing the stem, leaf blades 5–15 cm long, linear to lanceolate, the margins entire. Inflorescences terminal. Flower buds enclosed in a green spathe 1–2+ cm long with a proximal cluster of several flowers and distal cluster of vestigial flowers; proximal portion of the spathe margins fused. Flowers bilateral, probably 1.5–3 cm wide. Sepals 3, green. Petals 3, the upper 2 blue, the lower one much smaller and white. Stamens 6, the filaments glabrous and blue; fertile stamens 3, the middle one with an enlarged and bright yellow anther (like the antheroids), the other 2 bluish purple; sterile stamens (staminodes) 3, with bright yellow, lobed false anthers (antheroids). Fruits of capsules 3.5–4.5 mm wide, with 3 seeds each 3 mm in diameter.

Growing and flowering during warmer seasons, especially during hot, humid weather. The flowers open at dawn and remain open for a few hours and then wither and deliquesce (liquefy) into a gooey mass. The plants are generally seen only during the hot, humid summer-fall months following rains. Common in the Ajo Mountains, especially at higher elevations; eastward and northward in Arizona at the desert edge and elevations above the desert.

Arizona to Wyoming and eastern United States, to South America and in Africa. Weedy and introduced in many regions worldwide.

OP Bull Pasture Trail 3000 ft, 5 Nov 1977, *Bowers 957* (ORPI), 11 Sep 1988, *Wilson 191* Below saddle between Arch Canyon and Boulder Canyon, 26 Oct 2003, *Rutman 2003-1026-27* (ORPI)

CYPERACEAE Sedge Family

Annual (ephemeral) or herbaceous perennials, often grass-like. Stems triangular or cylindrical (terete) in cross-section and usually solid. Leaves mostly 3-ranked, differentiated into a sheath and a blade, the blade grass-like or sometimes reduced or absent, the sheath closed around the stem at least when young. Inflorescences frequently subtended by an involucre of 1 or more bracts, these often leaf-like or sometimes stem-like. Flowers (florets) small, sessile, in spikes or spikelets, subtended by small bracts (scales), arranged in spirals or 2-ranked; characteristically wind-pollinated. Perianth none or of few to many bristles or scales. Stamens 3, or sometimes 1 or 2. Ovary superior. Style 2-branched, the ovary 2-carpelled, and the fruit lens-shaped; or the style 3-branched, the ovary 3-carpelled, and the fruit 3-angled. Fruit a 1-seeded achene.

The eight species in the flora area are found in temporarily or permanently wet habitats and have broad geographic distributions.

1. Leaves reduced to basal sheaths, blades lacking; inflorescence with a single, terminal spikelet ..... **Eleocharis**
1. Leaf blades present but sometimes relatively short and near base of stem; inflorescences with more than one spikelet.

    2. Plants less than 1 m tall, widely scattered in the flora area; stems terete or triangular in cross section; spikelet scales 2-ranked (distichous), not spiraled; perianth bristles absent ... **Cyperus**
    2. Plants reaching 1 m or more tall, Quitobaquito and associate springs in the flora area; stems triangular in cross section; spikelet scales spiraled; perianth bristles present ... **Schoenoplectus**

Cyperus Sedges

Annual (or ephemeral) or perennial herbs. Stems solid, triangular or terete. Leaf blades mostly grass-like. Inflorescences terminal (sometimes appearing lateral when the terminal bract resembles an extension of the stem), the spikelets in simple or compound umbellate clusters, or the branches reduced; inflorescence branches (rays) often slender. Scales (bracts) of spikelets 2-ranked. Perianth none. Stamens 3 or occasionally 1 or 2. Style 2- or 3-branched. Achenes lens-shaped or triangular (trigonous).

1. Plants with creeping rhizomes; lower leaves reduced to sheaths, the upper leaf with a short, narrowly linear blade; style 2-branched; achenes lens-shaped (dorsiventrally flattened) ..... **Cyperus laevigatus**
1. Plants cespitose, tufted, not creeping but some with rhizomes; leaf blades well developed including those of lower leaves; style 3-branched; achenes 3-sided.

2 Diminutive ephemerals, mostly 3–10 cm tall, scales subtending flowers with recurved awn-tips, stamens usually 1 **Cyperus squarrosus**
2 Annuals or perennials, usually more than 15 cm tall, mostly 30–150 cm, scales straight, the tips awnless and not recurved, stamens 3

3 Roots with small round tubers at the ends of slender rhizomes, spikelets 9–40-flowered, conspicuously flattened, scales and spikelets persistent **Cyperus esculentus**
3 Roots lacking tubers, spikelets 1 or 2 (-5) flowered, more or less rounded in cross section (terete), scales and spikelets deciduous **Cyperus mutisii**

Cyperus esculentus Linnaeus
[*C. esculentus* var. *leptostachyus* Boeckeler]
Yellow nutgrass, *coquillo amarillo*, *cebollín*, vasai su vi. Figure 14

Hot weather (summer-fall rains) annuals in the flora area, perhaps sometimes perennials (elsewhere usually perennials), often (15–)30–60 cm tall. Stem base forming a single tuberous root with rhizomes growing out from this root, each rhizome ending in a single small, round tuberous root. Stems triangular in cross section. Leaves well developed. Involucral bracts leafy, of different lengths, often broader than the basal leaves. Spikelets 7–20+ × 1–1.8 mm, moderately flattened, the scales dull brown (especially when mature), the keels sometimes green (especially on young spikelets). Stamens 3. Style 3-branched, the achenes 3-angled.

Figure 14. *Cyperus esculentus*. Illustration by Lucretia Breazeale Hamilton.

Temporarily wet habitats in Cabeza Prieta, including playas and muddy, sandy-silt soils at dirt tanks and probably at other waterholes and arroyo beds.

This species is worldwide in warm temperate and tropical regions. If varieties are recognized, then those in Arizona are var. *leptostachyus*, which is native to the New World and introduced in the Old World (Tucker 2002; Yatskievych 1999). "This species and *C. rotundus* are the only New World species of *Cyperus* that produce stolons and tubers" (Tucker 1983: 41).

The small, tuberous roots are edible. Castetter and Bell (1951) reported that the seeds were eaten by the Cocopahs. The Gila River Pimas chewed fresh or dry tubers as a remedy for coughs or colds. To alleviate the effects of snakebite the tuberous roots were chewed and repeatedly applied to the wound (Curtin 1949).

CP Redtail Tank, shore of charco, *Simmons 12 Oct 1964* Las Playas 10 Oct 1958, *Monson 8*, 28 Nov 2001, *Felger 01-575*

Cyperus laevigatus Linnaeus
Flat sedge

Small perennials with creeping rhizomes, usually forming dense colonies (3) 10–20 (75) cm tall; also flowering in the first season. Lower leaves reduced to reddish or brownish sheaths, the upper leaf with a green, narrowly linear blade. Inflorescences compact, appearing lateral, with a cluster of sessile, scarcely compressed spikelets 4–15 mm long; involucral bracts 2, very unequal, the lower one 1.6–8.5 cm long, resembling a continuation of the stem, the other bract 0.4–2.3 cm long. Stamens 2. Style 2-branched, the achenes lens-shaped. Flowering and fruiting almost any time of year.

Emergent from very shallow water and in saline-alkaline wet soil. Apparently once abundant in wet soil at Aguajita, Williams, and Quitobaquito Springs and around the pond at Quitobaquito. After the cattle were removed the larger wetland plants probably became too dense for it to compete for light. Its local distribution seems to wax and wane with fluctuations in rainfall and density of vegetation cover (Felger et al. 1992).

Tropical to warm-temperate regions around the world.

OP Puerto Blanco Mts, 2000 ft, *Nichol 25 Feb 1939* Quitobaquito, 18 Mar 1945, *Gould 2983* Burro Spring, 4 May 1978, *Bowers 1314* Aguajita, wet sandy-gravel along streambed and immediately below the spring, these plants were not present prior to the flood of August 25 1988 (prior to the flood the stream was not running and was covered with dense growth of *Baccharis salicifolia*), 19 Jun 1989, *Felger 89-234*

Cyperus mutisii (Kunth) Andersson
[*C. asper* (Liebmann) O'Neill; *C. pringlei* Britton; *Mariscus mutisii* Kunth]. Figure 15.

Tufted perennials (or facultative annuals flowering in the first season?), to about 60 cm tall, mostly about half as tall, and probably with short rhizomes. Stems triangular in cross section. Leaves basal and well developed. Bracts subtending inflorescence leafy, the larger bracts longer than the inflorescence. Inflorescences of several to many rays with 1–3 spikes with numerous crowded spikelets. Spikelets 3–7 mm long, elliptic-oblong and more or less rounded in cross section. Stamens 3. Style 3-branched, the achene 3-sided. "Recognized by its cylindric spike borne digitately at the ends of the rays and its short, plump spikelets. As spikelets mature, the floral scales, having erose margins contrasting with the brownish sides, become useful distinguishing features" (Tucker et al. 2002: 189). Growing and reproductive during the warmer months.

Figure 15A. *Cyperus mutisii*. Brown Canyon, Cochise Co., Arizona, 23 August 1992, *McLaughlin 6783* (ASU).

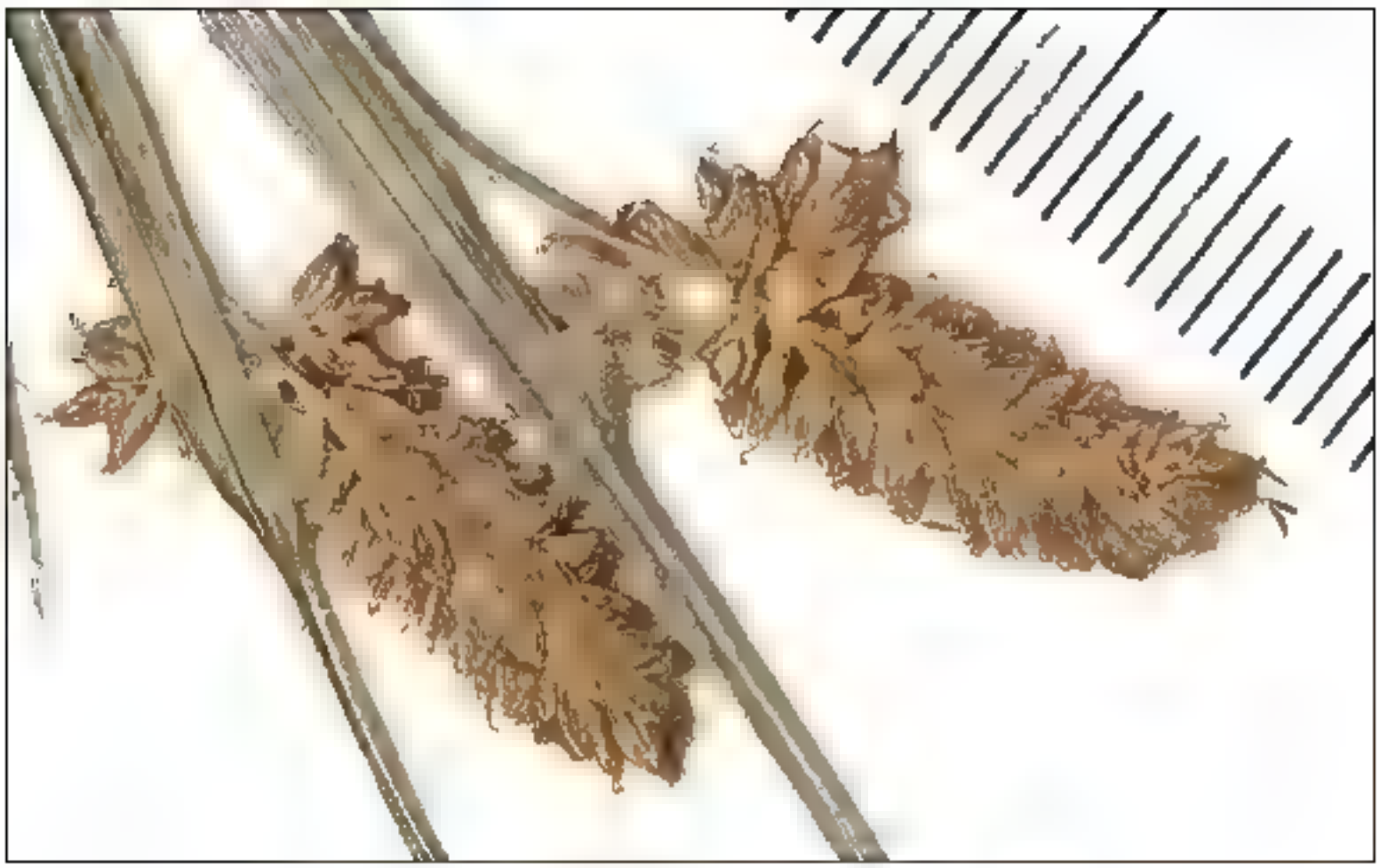

Figure 15B. *Cyperus manisuroides*. Brown Canyon, Cochise Co., Arizona, 23 August 1992. *McLaughlin 6783* (ASU). B. Two spikes.

In Organ Pipe known from the Ajo Mountains and one record on the valley floor near the west side of the Monument, which are the westernmost records for this species.

Southern and east-central Arizona and Mexico including Sonora to South America.

OP: W side Aramo Canyon, 13 Sep 1941, *Goodding 306-41*; Ajo Mts, moist slopes along arroyos, near summit, 28 Aug 1943, *Clark 1098* (ORPI); Bull Pasture, *Wirt 12 Nov 1989* (ORPI); Aramo Wash, just above spring house, *Rutman 27 Oct 1995* (ORPI); Growler Valley, near Bates Well Road and historic Palo Verde Camp Road, 32.15955°N 113.09.12°W, NAD 83, island about 0.1 acre of high density perennials and annuals adjacent to a Pleistocene terrace, common annual, 8 Oct 2006, *Rutman 2006-1008-2*.

Cyperus squarrosus Linnaeus
[*C. aristatus* Rottböll; *Mariscus squarrosus* Linnaeus; C.B. Clarke]
Dwarf sedge

Diminutive non-seasonal ephemerals, tufted and grass-like, 1.5–4(10–18) cm tall. Stems triangular in cross section. Leaves few, soft, basal or nearly so, usually less than 1 mm wide. Bracts subtending inflorescence leafy, the larger bracts longer than the inflorescence. Spikelets 4–10–15 mm long, laterally compressed, in compact clusters, sessile or on short rays. Each spikelet scale with a prominent recurved or sometimes straight awn-like tip, the awn tips giving an unusual "fringed" appearance to the spikelets, scales often reddish bronze to yellowish with green margins. Stamen 1, or sometimes with an additional 1 or 2 stamens or staminodes. Style 3-branched, the achene 3-sided.

Seasonally common in temporarily wet, fine-textured soils of the larger playas, sometimes at waterholes, and margins of larger washes. Reported by Bowers (1980) as abundant in moist soil near the pond at Quitobaquito, but it has not been documented there since that time. However, it is

common along the nearby Río Sonoyta in Sonora and perhaps extirpated from Quitobaquito since modification of the pond, removal of livestock, and expansion of *Schoenoplectus* (Felger et al. 1992).

Widespread in the Sonoran Desert in permanently to temporarily wet soils. Worldwide in temperate and tropical regions.

OP Moist sandy arroyo, N border of Organ Pipe, 11 Sep 1943, *Clark 10990* (ORPI)
CP Cabeza Prieta Tanks, *Monson 25 Sep 1955* (CAB) Las Playas 10 Oct 1958, *Monson 9*, 28 Nov 2001, *Felger 01-576* (ARIZ, ASU), SE end, numerous, associated species including *Marsilea*, 29 Nov 1997, *Harlan 416*
TA Vicinity of Coyote Water, 25 Oct 2004, *Felger 04-41*

Eleocharis Spikerush; *tulillo*

Ephemerals, annuals or perennials. Leaves reduced to two basal sheaths without blades. Inflorescences of a single, terminal spikelet, with a scale-like bract at the base. Flowers crowded; perianth of bristles, perhaps 3 8, reduced or sometimes absent. Stamens usually 3. Style 2- or 3-branched, the style base enlarging into a persistent tubercle capping the achene.

1. Coarse perennials with tough rootstocks; stems usually more than 45 cm long, oval to flattened in cross section..... **Eleocharis rostellata**
1. Delicate perennials or perhaps annuals (ephemerals); stems less than 30 cm tall, rounded in cross section.

   2. Stems 6 8 cm long; perianth bristles brownish, reduced or absent; achenes 3-sided, pale brown, the terminal tubercle of same color as achene body ..... **Eleocharis coloradoensis**
   2. Stems 6 28 cm long; perianth bristles white; achenes broadly lens-shaped, dark brown, the terminal tubercle white ..... **Eleocharis flavescens**

Eleocharis coloradoensis (Britton) Gilly
[*E. parvula* (Roemer & Schultes) Link ex Bluff et al. var. *anachaeta* (Torrey) Svenson]
Dwarf spikerush

Delicate plants 6 8 cm tall. This species is usually perennial with slender, creeping rhizomes and forms small tubers. Perianth bristles mostly absent or reduced. Achenes brown, 1.1 mm long, trigonous with one flat side, the tubercle reduced and the same color as the achene body.

This species was documented at Quitobaquito in 1940 and is presumably extirpated from flora area.

Widely scattered in Arizona including the lower Colorado River and Sonora including the Río Colorado delta. Mexico to Canada and across the USA.

OP Quitovaquito W edge of pond, 5 Mar 1940, *Peebles 14565* (det G Tucker, Apr 2012), Pond, 3 Jun 1940, *Peebles 14801 & Parker* (det G Tucker, Apr 2012)
Sonora Delta region of Río Colorado, Ciénega de Santa Clara, 20 May 1992, *Felger 92-521*

Eleocharis flavescens (Poiret) Urban var. **flavescens**
Yellow spikerush

Perennials or perhaps sometimes annuals, potentially forming rhizomes. Stems often 6 28 cm long, slender and delicate, straight, mostly erect or ascending and not curved. Leaf sheaths prominent. Spikelets globose to ovoid, 3 7+ mm long. Perianth bristles probably (5) 7 (8), white, backwards barbellate. Style branches 2. Achenes 0.5 1 mm long, broadly lens-shaped, obovoid, shiny dark brown, the tubercle white, constricted at the base. Flowering at least March November.

Reported as once abundant in moist soil near the pond and springs at Quitobaquito, and locally infrequent or rare after the late 1980s. This small spikerush apparently requires open wetland habitat (see comments for *Cyperus squarrosus*).

The tiny barbs on the perianth bristles hook tenaciously onto bird feathers, which seem to explain the large geographic range of this and many other cyperaceous species. Numerous achenes were found attached to bird feathers floating in small pools at Quitobaquito.

Temperate North America to South America and the West Indies.

Eleocharis flavescens is similar to *E. geniculata* (Linnaeus) Roemer & Schultes [*E. caribaea* (Rottbøll) S.F. Blake], differing in part by the brown rather than black achenes.

OP Quitobaquito, in moist soil along stream, 17 Mar 1945, *Darrow 2402, 2403* Quitobaquito, about 4 colonies, emergent from shallow water with pupfish, not seen elsewhere, 10 Nov 1987, *Felger 87-297* (ASU) Vicinity of Quitobaquito Spring, 0 5 km N of pond, rocky-gravelly wash, apparently rare and localized in arroyo bed, emergent from very shallow water and alkaline-wet soil, 6 Apr 1988, *Felger 88-313*

Eleocharis rostellata (Torrey) Torrey
Traveling spikerush. Figure 16.

Perennial herbs with tough rootstocks; forming large, grass-like mounded colonies. Stems bright, shiny green, wiry and tough, often 45–100+ cm long, oblong in cross section when fresh, becoming flattened, thick, and ridged when dry. Sometimes producing plantlets at the stem tips that may develop into new plants (Figure 16C). Spikelets 4–12 mm long. Perianth bristles reddish brown, unequal in length, some longer than the achene, backwards barbellate. Style branches 3, or sometimes 2 in some florets in a spikelet. Achenes vaguely 3-angled to thickly lens-shaped, the tubercle dull white and continuous with the achene body (not constricted basally). Reproductive at least March May and September November.

Figure 16A. *Eleocharis rostellata* Quitobaquito, Organ Pipe Cactus NM, 5 May 2005, photo by Sue Rutman

ASU
2453
Plants of Arizona
ARIZONA STATE UNIVERSITY
Eleocharis rostellata (Torr.) Torr.
Family: Cyperaceae
Arizona, Cochise County. San Pedro Riparian National Conservation Area.
Upper San Pedro River floodplain, St. David Cienega, middle portion.
Habitat: cienega (seasonally dry periphery).
Associated spp.: Schoenoplectus americanus, Carex praegracilis, Distichlis spicata, Hordeum jubatum, Sporobolus airoides, S. wrightii
Notes: Rhizomatous perennial; inflorescences slightly geniculate; abundant in cienega.
Collected by: Elizabeth Makings 1093 15 July 2002

Figure 16B *Eleocharis rostellata* St. David Cienega, San Pedro River floodplain, Cochise Co., Arizona, 15 Jul 2002 *Makings 1093* (ASU)

Figure 16C *Eleocharis rostellata* Quitobaquito, plantlet at stem tip, 5 Apr 2013, live plant scanned by Sue Rutman

Stands of this large spikerush cover local areas of alkaline wet soil at Quitobaquito at springheads, along spring channels and the artificial channel, and around the pond perimeter The stems persist long after they die and form "haystacks" at springs and spring channels at Quitobaquito Small mammals form tunnels inside the haystacks and constant maintenance is required of the Park Service to keep the artificial channel from being closed by this spikerush

Also at the La Salina oasis at Bahía Adair and along the margins of the Río Colorado delta in northwestern Sonora (Felger 2000), but unknown elsewhere in nearby Arizona and northwestern Sonora Most of North America, West Indies, and South America

OP Quitobaquito 25 Mar 1941, *McDougall 35*, 9 Mar 1973, *Felger 20591*, 6 Apr 1988, *Felger 88-319*, 23 May 1991, *Baker 8363A*, *Rutman 5 Apr 2013*

Schoenoplectus americanus (Persoon) Volkart ex Schinz & R Keller
[*Scirpus americanus* Persoon, *S. olneyi* A Gray]
Bulrush, *tule*, va k Figure 17

Perennials spreading by long, tough rhizomes to form large colonies Stems (0 2) 1 2+ m tall, solid (pithy) and triangular in cross section Leaves few, basal or nearly so, the blades relatively reduced, 1 7–15 cm long Inflorescence subtended by a single 3-angled bract appearing as a continuation of the stem, the inflorescence a cluster of sessile or nearly sessile, ovoid spikes appearing lateral to the bract near the stem tip Perianth bristles mostly 4, slightly longer than the achene Styles 2- or 3-branched Achene body 1 7 2 3 mm long, obovoid, more or less lens-shaped or perhaps sometimes obtusely 3-angled, the surface dull Apparently reproductive March December

Figure 17A. *Schoenoplectus americanus* in foreground, *Tessaria sericea* in middle, and *Populus fremontii* and *Prosopis glandulosa* in background, Quitobaquito, Organ Pipe Cactus NM, 5 May 2005, photo by Steve Rutman.

Wet soil and emergent from irrigation ditches and shallow water ringing the pond and at springs at Quitobaquito, and at Aguajita, Burro, and Williams Springs, locally abundant, often forming near pure stands of 100% coverage. This large, robust sedge has thrived and increased in the Quitobaquito region since removal of the cattle, apparently leading to the local extirpation of various smaller wetland plants, e.g., *Cyperus squarrosus*, *C. laevigatus*, *Juncus bufonius*, *Myosurus minimus*, and *Poa annua*. The densely packed root system can be several feet thick, eventually forming dry land and excluding the living plants. Constant maintenance is required of the Park Service to keep the artificial channel at Quitobaquito from being closed by this bulrush.

Common in wetlands in nearby Sonora and along the lower Colorado River. Widespread in wetland habitats in the Americas.

Lumholtz (1912: 331) reports that Hia C'ed O'odham made baskets from bulrushes, perhaps *Schoenoplectus americanus*

OP: Burro Spring, 4 May 1978, *Bowers 1313* **(ORPI). Quitobaquito: 5 Mar 1940,** *Peebles 14564*, **Abundant at margin of pond and near springs, 6 Apr 1988,** *Felger 86-320*.

Figure 17B *Schoenoplectus americanus*. **Quitobaquito, 5 April 2003, photo by Sue Rutman.**

Figure 17C. *Schoenoplectus americanus*. Mangus, Burro Mountains, Grant Co., New Mexico, 7 June 2009. Inflorescence and floral bract. Photo by Russ Kleinman (gilaflora.com).

Lumholtz (1912: 331) reports that Hia C'ed O'odham made baskets from bulrushes, perhaps *Schoenoplectus americanus*.

OP. Burro Spring, 4 May 1978, *Bowers 1313* (ORPI). Quitobaquito, 5 Mar 1940, *Peebles 14564*, Abundant at margin of pond and near springs, 6 Apr 1988, *Felger 86-320*.

HYDROCHARITACEAE – Waterweed Family (includes Najadaceae)

Najas marina Linnaeus
Holly-leaf water-nymph, *sargazo*. Figure 18.

Submerged aquatic herbs, presumably annual. Stems branched, often more than 50 cm long, 1–2.3 mm in diameter, rooting at base and from lower nodes. Stems and leaf margins and midrib on lower surfaces with relatively thick, firm spines. Leaves sub-opposite and mostly appearing whorled, becoming firm with age, leaf blades sessile, linear, (1.2–)1.5–3 cm × 2.5–5 mm. Male and female flowers on separate plants, flowers inconspicuous, axillary and 1 per axil, hidden in leaves clustered at branch tips, perianth none. Male flowers with a single stamen, the anther sessile or subsessile. Female flowers sessile, stigma branches 3, the fruits achene-like, 1-seeded.

Figure 18. *Najas marina*. Quitobaquito, Organ Pipe Cactus NM, 20 May 2013, fresh plant scanned by Sue Rutman

Locally extensive in the Quitobaquito pond, the artificial channel, and springhead. The plants are most abundant during the warm season, when they nearly fill the artificial channel. The nearest known population occurs in the Ciénega de Santa Clara at the Río Colorado delta where it is abundant (Felger 2000) and scattered localities along the Colorado River. Unlike the other submerged aquatics, *Ruppia*, *Stuckenia*, and *Zannichellia*, the stems and leaves of *Najas* are relatively firm and spinose.

Warm regions worldwide, native to the New World and introduced in the Old World.

OP: Quitobaquito Springs, 1 Oct 1965, *Pinkava 2363* (ASU). Common in Quitobaquito Pond, also common in the spring channel, with *Ruppia* and *Stuckenia*, *Tibbitts 14 Jul 2005*.

IRIDACEAE Iris Family

Sisyrinchium demissum Greene

Blue-eyed grass. Figure 19.

Perennial herbs with fibrous roots and many stems. Leaves numerous, slender and grass-like, folded lengthwise like an iris. Flowers about 1.5 cm wide in small umbel-like clusters, blue-violet with a yellow center; tepals 6, petal-like and tipped with a small point. Flowers recorded in April. Fruits of many-seeded capsules.

Fig 19A. *Stenocereus thurberi* Quitobaquito Organ Pipe Cactus NM. 5 April 2015. Photo by Steve Rutman

Fig 19A. *Sisyrinchium demissum*. Quitobaquito, 5 April 2013. Photo by Sue Rutman

Sue Rutman discovered one well-established patch in permanently damp soil at Quitobaquito in 1999 and by 2001 it was thriving and increasing in size. In 2013 the colony had increased to about one meter in width. This is the only record for a blue-eyed grass well within the Sonoran Desert. *Sisyrinchium* is not known to be bird dispersed (Lisa Karst, pers. com. to R. Felger, 2004).

Widespread in non-desert areas Arizona and a few records at the desert edge such as a wetland area northeast of Tucson (see Cholewa & Henderson 1993). Also Nevada, Utah, and southern Colorado to western Texas, eastern Sonora, and Chihuahua (Karst & Wilson 2012).

OP Quitobaquito, seep site, moisture probably present year-round, one small patch, flowering and fruiting, flowers blue with yellow center, *Rutman 23 Apr 1999* (ORPI)

Pima County La Cebadilla, property owned by Pima Co. Flood Control Dist., in wet meadow, *Titus 6 Jun 2001* [NE of Tucson, 2710 ft]

JUNCACEAE Rush Family

Juncus Rush

Annual and mostly perennial herbs, glabrous, and with rhizomes or cespitose. Leaves alternate, scale-like on the rhizomes, cataphyllous (with reduced blades), and or leafy on the base of the stem with a sheath and blade, the blades often stiff and bract-like in the inflorescences. Perianth radial, small and inconspicuous, the tepals 6 in 2 sets, mostly greenish to brownish, not petal-like. Stamens mostly 6, sometimes 3 or fewer. Ovary superior. Fruit a capsule; seeds numerous. Three wetland species in flora area are known only in the vicinity of Quitobaquito.

1. Annuals, mostly 15–20 (30) cm tall; stems and leaves soft and flexible, not spine-tipped ..... **Juncus bufonius**
1. Perennials, usually 40–200 cm tall; stems and leaves firm and spine-tipped.

   2. Plants cespitose, forming dense pincushion-like large clumps without long rhizomes; stems rounded in cross section (terete) ..... **Juncus cooperi**
   2. Stems arising from long, deeply-set rhizomes; stems often compressed (oblong in cross section) ..... **Juncus mexicanus**

Juncus bufonius Linnaeus
Toad rush

Small annuals, cespitose and tufted, with soft, flexible stems and leaves. Larger plants with branched stems often to 15–20 cm tall, the leaves mostly basal but some along stems. Tepals slender with a green mid-stripe and nearly transparent membranous margins.

Known from the flora area by a single collection in 1944 at the edge of the Quitobaquito pond and since extirpated. Its demise probably was due to lack of shallow water and open wetland because sedges and other larger wetland plants have become dense since the removal of cattle and dredging of the pond.

There are no records for this wetland species in northwestern Sonora or nearby Arizona. The nearest population is along the lower Colorado River near Yuma (Laguna Dam; Southwest Environmental Information Network 2013). This species is nearly worldwide in distribution.

OP Quitobaquito, edge of pond, 25 Mar 1944, *Clark 11501* (ORPI)

Juncus cooperi Engelmann
Spiny rush, Cooper's rush

Large cespitose tussock-forming perennial rush resembling a giant pincushion to about 1 m tall. Stems often firm, terete, ending in a spine-tipped involucral bract more or less continuous with the stem. (The portion below the inflorescence is stem and the part above is bract.) Leaves arising from the base, spine-tipped, resembling and often nearly as long as the stems. Inflorescences appearing lateral near the end of leaf-like stems. Panicles often compound, the branches unequal, the flowers in small clusters, the bracts spine-tipped. Outer tepals 4–6 mm long, acute with firm, often spinescent tips, the margins entire or with narrow membranous wings. Capsules ovoid, about as long as or slightly longer than the tepals. Growing and flowering during warmer seasons.

Locally common in mostly damp to wet soil on alkaline-saline flats between Quitobaquito and Burro Spring and below the springs at Quitobaquito, often growing with *Sporobolus airoides*. Not known elsewhere in Arizona. This is an outlier population; the nearest and much larger populations occur in similar habitats along and near the lower Río Colorado in Mexico.

Otherwise known from moist saline soils in deserts in southeastern California, southern Nevada, and northeastern Baja California along the lower Río Colorado.

OP Saline flats between Quitobaquito and Burro Springs, 4 May 1978, *Bowers 1309* (ARIZ, ORPI) Quitobaquito, 10 Nov 1987, *Felger 87-300d*

Juncus mexicanus Willdenow ex Roemer & Schultes f.
[*J. articus* Willdenow var. *mexicanus* (Willdenow ex Schultes & Schultes f.) Balsev; *J. balticus* Willdenow var. *mexicanus* (Liebmann) Kuntze]
Mexican rush

Perennials with long, deep, blackish and creeping rhizomes. Stems erect, 35 75 cm, firm, tough, often twisted and laterally compressed (oblong in cross section), bearing 1 or 2 basal, sheathing leaves, these brownish, the longer one often 4–8 cm. Inflorescences 3.5 8.5 cm long, appearing lateral. Growing and flowering during warmer seasons.

Locally abundant at Quitobaquito in alkaline wet or damp soil at springs and seeps; often growing with *Distichlis spicata*. Also a small population nearby along the Río Sonoyta in Sonora (Felger 2000). There are no other records for this species in nearby Sonora or Arizona.

Southwestern United States to Central and South America.

OP Quitobaquito 22 Aug 1981, *Reichhardt 69*; 24 Oct 1987, *Warren 87-122*, 23 Jul 1986, *Felger 86-211*, 23 May 1991, *Baker 8364* (ASU, DES)

LILIACEAE Lily Family

Five species in five genera of "bulb" (corm) forming plants, or geophytes, in the flora area were once grouped in the catch-all, polyphyletic and artificial lily family, along with nolinas and yuccas. The sixth bulbous geophyte, *Habranthus* (*Zephyranthes* in part) has long been in Amaryllidaceae. Wiggins (1964) includes 20 species of bulbous geophytes in Liliaceae for the flora of the Sonoran Desert. Most of them occur at the margins of the desert, especially along the Pacific Coast, and at higher elevations such as at the northern and eastern margins of the desert. The bulb growth form seems well adapted to climates with dry summers and cool winters and is generally rather poorly represented in the core area of the Sonoran Desert.

Calochortus remains in Liliaceae, *Allium* and *Habranthus* are in Amaryllidaceae, and *Dichelostemma*, *Hesperocallis*, and *Triteleiopsis* are in Asparagaceae. *Habranthus* grows and flowers during the warmer months. The other five bulbous geophytes grow and flower during the cooler months and the plants are dormant during the hottest months. The fruits of these six geophytes are capsules that ripen in the same season shortly after flowering.

Calochortus kennedyi Porter
Desert mariposa lily; *ajo amarillo, cobena amarilla*; ha:dkos. Figure 20.

Perennials from a deeply buried and relatively large bulb; plants glabrous. Larger leaves basal, several, thick, glaucous, probably 10–20 cm long, 2–5 mm wide at mid-length. Flowers 2–4 in umbels, bell-shaped, bright orange with a dark center and with 6 tepals: 3 smaller, outer tepals (sepals) and 3 larger inner tepals (petals), each 2.5 3.5 cm long with a dark purple nectary near the base and thickened, bright orange club-shaped hairs above the nectary. Anthers purple. Capsules 5 cm long, erect, and 3-angled; seeds numerous. Growing in spring, flowering in April, and dormant after fruit ripens in May.

Figure 20A. *Calochortus kennedyi*. Bull Pasture, 10 April 2005, photo by Sue Rutman. Note the purple anthers, white ovary, and club-shaped hairs above the dark nectary

Rocky soils at mid- to upper elevations in the Ajo and Diablo Mountains. The nearest populations are at higher elevations in the Sand Tank and Table Top Mountains in the Sonoran Desert National Monument.

East and northeast from the flora area in southern and central Arizona, southern Nevada, southern California, and northern Sonora. Two doubtfully significant but geographically segregated varieties, based on flower color, are sometimes recognized, var. *kennedyi* occurs in the flora and is the southern variety.

The bulbs were cooked or sometimes eaten fresh (Hodgson 2001b). The bulb is called *ajo amarillo* and people in north-central (e.g., Sierra del Humo) and northwest Sonora (e.g., Sierra la Jojoba) eat the bulbs. The bulbs are yellow compared to those of *Dichelostemma capitatum*, *ajo blanco*, which are whitish (Ana Lilia Reina, pers. comm. to R. Felger, 2005).

OP. Bull Pasture trail, 12 Apr 1949, *Bean 49*-1 (ORPI). Bull Pasture, 3300 ft, 5 Apr 1978, *Bowers 1200* (ORPI), 9 Apr 2005, *Felger 05-176*.

Figure 20B. *Calochortus kennedyi*. Bull Pasture, Ajo Mountains, Organ Pipe Cactus NM, 10 April 2005; photo by Sue Rutman.

Figure 20C. *Calochortus kennedyi*. Immature fruit with withered tepals–showing one larger, inner tepal and two smaller, outer tepals. Bull Pasture, 10 April 2005; photo by Sue Rutman.

NAJADACEAE, see HYDROCHARITACEAE

NOLINACEAE, see RUSCACEAE

POTAMOGETONACEAE Pondweed Family

The three species in the flora area are submerged aquatics with slender stems and leaves, and small, inconspicuous flowers. They are known from the Quitobaquito pond and one record from an artificial water hole. The small seeds are undoubtedly bird-dispersed.

1. Leaves opposite; fruits laterally compressed (flattened), oblong (longer than wide), with small teeth on a crest ..... **Zannichellia**
1. Leaves alternate or sometimes subopposite, or opposite; fruits nearly round to ovoid (about as wide as long), keeled or not, but not toothed.

    2. Leaves 1–3(–5) veined, 1–2 times as long as the internode; stipular sheaths free, up to 1 cm long; fruits 1.5–2.2 mm long, not keeled ..... **Potamogeton**
    2. Leaves 1-veined, 3–4 times as long as the internode; stipular sheaths 1–3 cm long, with only the 2–10 mm tip free; fruits 3–4.5 mm long, with low dorsal keel ..... **Stuckenia**

Potamogeton pusillus Linnaeus

Submerged aquatics, probably perennials with slender rhizomes. Leaves thread-like 1–2 times as long as the internode, 1–3(–5) veined, with stipular sheaths free, up to 1 cm long. Fruits 1.5–2.2 mm long, not keeled. The plants resemble *Stuckenia pectinata* and some specimens labeled as *Stuckenia* might be *P. pusillus*.

Known from the flora area by a single collection from the pond at Quitobaquito. North America and Eurasia.

OP: Quitobaquito, 1080 ft, submerged herb, mixed collection with *Stuckenia pectinatus*, 3 May 1991, *Baker 8360-B* (ASU, DES, images).

Stuckenia pectinata (Linnaeus) Börner
[*Potamogeton pectinatus* Linnaeus; *Coleogeton pectinatus* (Linnaeus) Les & R.R. Haynes]
Sago pondweed

Submerged aquatics, apparently perennial, forming tangled filmy green masses with very slender stems to more than 50 cm long. (This species is reported to have slender creeping rhizomes at the end of which is a white tuberous root 1–1.5 cm, but tuberous roots are generally absent from specimens from Mexico and adjacent Arizona.) Leaves alternate, 2-ranked, thread-like, 5–15 cm long, the leaf sheaths membranous and nearly transparent, the blades 0.5 mm wide, the tip acute and entire, 1-veined. Inflorescences of very slender necklace-like spikes not enclosed in a leaf sheath, the peduncles often 5.5–12.5 cm long, the flowers and fruits in unevenly spaced whorls, the fruiting spikes 1.8–2.5(–3) cm long. Flowers inconspicuous, 4-merous; perianth segments of 4 brownish green tepals, the stamens 4, the pistils 4 and separate. Fruits, 2.5–4 mm long, sessile, brown, 1-seeded, ovoid, asymmetric, slightly compressed, and with a low dorsal keel. Growing and reproductive during warmer months.

Locally abundant in the pond at Quitobaquito, growing with *Najas*, *Ruppia,* and *Zannichellia* in shallow water to a depth of about 1 m. Also in reservoirs and ponds in nearby Sonoyta and at Quitovac in Sonora.

Nearly worldwide; in North American from Alaska southward. It is an important food plant for waterfowl.

OP Quitobaquito 13 Sep 1986, *Felger 86-270*, 14 Sep 1988, *Felger 88-455* Quitobaquito, 23 May 1991, submerged herb with inflorescences floating on surface, tepals and stigma brown, anthers cream-white, *Baker 8360-A* (ARIZ, det. Jon Ricketson, 3 May 1991, DES, image)

Zannichellia palustris Linnaeus
Horned pondweed

Submerged aquatic herbs, probably annuals, or perhaps perennials or both, forming tangled masses. Stems thread-like. Leaves opposite, 2 10 cm long, thread-like, entire. Flowers unisexual, male and female flowers usually in the same small cluster in leaf axils. Each male flower reduced to a single stamen. Each female flower with a cluster of often 4 separate green carpels (1 or more often breaking off), each carpel with an open, flared (peltate) stigma. Fruits (carpels) 3 4.2 mm long (including stipe and beak), asymmetric, flattened, oblong, prominently beaked, often with small teeth or prickles on a crest and sometimes on the body, or smooth and entire, 1-seeded.

Shallow water in the pond at Quitobaquito, and sometimes extending into streams and ditches associated with the pond. Also in an artificial waterhole ("guzzler") in Cabeza Prieta, probably brought in by birds.

Worldwide in fresh and brackish water.

OP Quitobaquito 5 Mar 1940, *Peebles 14566*, 13 Sep 1987, *Felger 86-270*
CP Little Tule Guzzler, Charlie Bell Area, 14 Apr 1997, *Harlan 471*

RUPPIACEAE Ditch-grass Family

Ruppia cirrhosa (Petagna) Grande
Ditch-grass.

Small, submerged herbs, probably annuals. Stems very slender. Leaves alternate, 4–10 cm long, expanded at the base into a prominent, membranous, nearly transparent sheath of fused stipules, the blades threadlike, less than 0.5 mm wide, the apex acute to obtuse with submicroscopic teeth. Inflorescences of 2 flowers, one above the other on opposite sides of the peduncle. Perianth none, the stamens 2, each with 2 prominent anthers, the pistils 4, separate, symmetrical or nearly so, ovoid to pear-shaped, sessile in young flowers, with stipes (stalks) elongating in fruit. Inflorescence at first enclosed in a membranous spathe inside the expanded leaf sheath, the peduncles pushing through the sheath and greatly elongating and to elevate the flowers to the surface of the water. After pollination, the elongated peduncles coil, re-submersing the floral structures. Each flower producing 4 hard brown nutlets 2 × 1 mm, each with a single seed 1 mm in diameter. (Caution: do not confuse the 2 stamens for 2 separate male flowers, nor the 4 separate carpels or nutlets for 4 separate female flowers.) Actively growing, flowering, and fruiting April through summer. The coiled peduncles form knotty structures that help in field identification; these are lacking in *Stuckenia* and *Zannichellia*.

Locally abundant in the pond at Quitobaquito during warmer months, growing with *Najas*, *Stuckenia*, and *Zannichellia*. Also in reservoirs and ponds in the vicinity of Sonoyta. The coiled peduncles align the population with *R. cirrhosa*, the inland taxon.

Worldwide; in North America from Alaska and Canada southward. *Ruppia* is an important food plant for waterfowl.

OP Quitobaquito *Henderson* 23 Nov 1971, 23 Jul 1986, *Felger 86-222*

RUSCACEAE, see ASPARAGACEAE

THEMIDACEAE, see ASPARAGACEAE

TYPHACEAE Cattail Family

Typha domingensis Persoon

Southern cattail, *tule*, 'uduvhag Figure 21

Robust perennial herbs, emergent from shallow water or wet soil at various waterholes and springs, glabrous and with starchy rhizomes Winter dormant, the above-water portions frost sensitive, although some Organ Pipe populations usually remain green through the winter Leaves erect and strap-shaped, to 2+ m tall × 6 14 mm wide, the lower portion spongy and thickened, the inner surface flat, the outer surface convex Flowers unisexual, extremely numerous and minute, densely packed on tall cylindrical spike-like inflorescences, male portion of inflorescence separated from the female portion by a barren gap (an interval without flowers) Fruits minute, single-seeded, achene-like (follicles), and wind-dispersed

Figure 21 *Typha domingensis* Illustration by Lucretia Breazeale Hamilton

Seedlings are submerged and have flaccid, ribbon-shaped leaves. The tiny, lightweight fruits (0.02 0.03 mg) and associated hairs may be airborne over great distances, and are probably also bird-disseminated. The seeds are reported to remain viable for many years and a single spike may produce 680,000 seeds.

Persistent colonies occur at scattered, permanent waterholes across the flora area, and small local colonies or individual plants come and go with fluctuations in standing water. Some of the colonies, consisting only of small plants, are probably not reproducing. More than five centuries ago cattails grew at a Hohokam water-storage reservoir in Organ Pipe that was built around a hand-dug well (Bayman & Palacios 2002; Bayman et al. 2004).

Two persistent colonies occur at upper elevations of the Ajo Mountains, in the north and south forks of Alamo Canyon. A 1950 photo of Williams Springs shows a small, well-established colony, but by the mid-1980s it had receded, apparently crowded out by *Phragmites* and *Schoenoplectus* (Felger et al. 1992). In 1987, a few small cattail colonies, apparently not reproducing, were found in alkaline wet soil at seeps above Quitobaquito, and in summer 1989, a well-established colony grew along a ditch below the springs (Felger et al. 1992). *Eleocharis rostellata* and *Schoenoplectus* crowd out *Typha* and the park staff has worked to maintain cattails at Quitobaquito in a pool along the concrete channel from one of the springs.

In September 1988, a single colony, obviously a number of years old, was found at Aguajita Spring; it had not been seen earlier in the year or during the previous several years. There was a mass of large, old, and gnarled rhizomes, about 1 m across, and a number of fresh new shoots. These rhizomes had been exposed by the scouring flood of 21 August 1988. Apparently the rhizomes had remained dormant, perhaps for decades, beneath the sand and gravel and a dense cover of seep willow (*Baccharis salicifolia*) and bulrush (*Schoenoplectus americanus*). By December 1988 these cattails had reached near-adult size. In spring 1990, the colony was thriving but had not spread.

Cattails and their habitat at Agua Dulce Spring in Cabeza Prieta were destroyed when the spring was "enhanced" (U.S. Fish and Wildlife Service 1951): "Agua Dulce Spring, formerly clogged with *Typha*, was cleaned and concrete lip added. Channel below natural tank had been covered up to a thickness of 4 feet." Cattails probably once grew at Tule Tank and Tule Well, as indicated by the name and oral history (Broyles et al. 1997, 2007). At Tinajas Altas cattails were seen at a mid-elevation tinaja during the 1970s and 1980s, and a specimen was obtained in 2008. This is the only wetland plant species known from Tinajas Altas.

Wetland habitats across the Sonoran Desert; brackish and fresh water across the southern 2 3 of the United States and most of tropical America, and in the Old World.

Many parts and growth stages were eaten either fresh or cooked, including young submerged plants, young shoots, young stem bases, rhizomes, tender developing inflorescences, pollen and flowers, and seeds (achenes) (e.g., Bean & Saubel 1972; Gifford 1933; Hodgson 2001b; Kelly 1977; Nabhan et al. 1982; Palmer 1878; Rea 1997; Williams 1987). The pollen (called "flower heads" or "pollen heads," which may be flowers including pollen) was eaten in substantial quantities; its collection and preparation was hard work, but it was highly prized for adding a sweet flavor to many dishes (e.g., Curtin 1949; Kelly 1977: 39). Gifford (1933: 268) also reported that the fresh "pith of [the] stems" was eaten Sue found that it has a mild cucumber taste. Cattail food products were often stored (Gifford 1933; Hodgson 2001b). Kelly (1977: 39) mentioned that the pollen "was considered a particularly potent medicine and was used in a curing ceremony sponsored by a Yavapai religious leader who made frequent visits to the Cocopa community [in Arizona]." The Hia Ced O'odham "would use cattail for making baskets" (Betty Melvin in Zepeda 1985: 66).

OP: Alamo Canyon (north), ½ mi up from well, *Hustafa 6 Jun 1987* (ORPI). Aguajita, 19 Jun 1989, *Felger 89-235.* Upper S fork of Alamo Canyon, 17 Jan 2002, *Tibbitts* (photo). †North-central portion of Organ Pipe, Hohokam reservoir, pollen, 539 to 753 ybp (Bayman & Palacios 2002).

CP: Buckhorn, Halfway, and North Pinta Tanks (Simmons 1966). Observations, *Felger,* 12 Jun 1992: Cabeza Prieta Tanks, small reproductive stand; Granite Pass Tank, small emergent plant beneath roof covering the tank.

TA: Bill Broyles (pers. com. to R. Felger, 13 July 2008: "I've seen cattails at TA. . . . mid-1980s. . . They were in pool #4 (see Bryan 1925: 133), which is a wide (about 25 ft perpendicular to flow), narrow (5 ft parallel to flow), inaccessible pool midway up the plunge-pool series and above, not beside, the wedged boulder. Generally it is filled with sediment and only once have I seen standing water in it, up to 60 cm deep, but the sediment undoubtedly holds moisture for a long time. It is a 'shelf' tinaja. I've not seen them at any other pool, for they may be too frequently scoured to support *Typha.*" Tinajas Altas tank, 10 Mar 1980, *Barry Spicer* (observation, *in* Van Devender field notes). Label for *Cheilanthes parryi* (*Engard 920*, 18 Apr 1976, ASU): "above the tinaja containing *Typha*." Tinajas Altas, "cattails at tanks," 12 Feb 1977, *Reeves* (observation recorded in field notebook). Tinaja #4, sheltered trench in damp soil at the edge of the tinaja, 20 Nov 2008, *Wilder 08-383* (also photo, Felger et al. 2012).

ZANNICHELLIACEAE, see POTAMOGETONACEAE

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